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CONTENTS.

An Asterisk (*) denotes an illustrated article.

NOTICES—

Announcement, Third Annual Meeting, Iowa District Gas Association 925

Wrinkle Department, The American Gas Institute 925

EDITORIALS—

Briefly Told 925

What Will Come Next?—The Joplin Meeting of the Natural Gas Association—The Philadelphia Situation—Current Comment.

The Development of Gasholder Construction, by Mr. Geo. H. Cressler 926

*Accidents with Gas Engines Due to Belts, by "R." 927

*Pneumatic Pipe Dredge 928

*The Anderson Cushioned Type B Nonreturn Valve 929

*Steam in Gas Producer Practice, by W. A. Bone, Ph.D. 929

The Washington Coal Situation, by Mr. R. P. Tarr 934

The May Meeting of the Illuminating Engineering Society, Chicago Section 934

Note on the Adiabatic Change on Mixing Two Gases, by Mr. A. J. Lotka 935

Explosive Phenomena of Mixtures of Gas and Air 936

Rapid Method for Estimating Acetone 937

Power Plant Diaries 938

ITEMS OF INTEREST FROM VARIOUS LOCALITIES 938

Manitowoc will Not Have the Plant—Annual Meeting, Grand Rapids, Mich.—New Offices, W. G. C. Co.—Three Personals—Death of Mr. D. N. Tiernan—A Happening in Wilkes-Barre, Pa.—New Office Quarters, Federal Gas Co.—Gas Plant for Goldfield, Nev.—Meter Inspection, Cleveland, O.—Two Personals—Death of Mr. John Turner—An Interesting Opinion, Baltimore, Md.—And Other Items.

The Market for Gas Securities 940

[NOTICE.]

Announcement of the Third Annual Meeting, Iowa District Gas Association.

The Third Annual Meeting of the Iowa District Gas Association will be held in Cedar Rapids, Ia., June 12th, 13th and 14th.

Headquarters and place of meeting will be at the Montrose Hotel. The Hotel offers rates on the American plan of $2.50 per day up, and European plan $1 per day up. Best accommodations are always secured by reservations made in advance.

In addition to the regular set papers, the Council has decided upon the following topics for general discussion as being of broad interest to all members of the Association. The subjects will not be specifically assigned, but the Chairman will call upon the various members for their ideas and experiences in any or all of the subjects:

"Removal and Disposal of Tar."

"Purification."

"Prepaid Meters."

"Removing Meters versus Shutting-Off Gas with or without Lock Cocks."

"Minimum Charges."

The following papers will be presented:

"Experiences in Operating Water Gas Machines," by Mr. L. H. Reuping, Sioux City, Ia.

"Attitude of Gas Companies Toward the Public," by Mr. Jansen Haines, Des Moines, Ia.

"The Organization of Gas Companies in Towns of Less Than 10,000 Inhabitants," by Mr. Geo. H. Waring, Omaha, Neb.

"High Pressure Transmission," by Mr. L. H. Lawlor, Waterloo, Ia.

"Arc Lamp Maintenance: Methods and Results," by Mr. J. C. Grey, Des Moines, Ia.

"New Business," by Mr. A. W. Zahm, Mason City, Ia.

"Accidents and Damages," by Mr. G. M. Averill, Cedar Rapids, Ia.

"Standard Methods in Service: Meter and Appliance Fittings."—Short Topic, by Mr. G. I. Vincent, Des Moines, Ia.

The "Wrinkle Department" will be conducted by Mr. H. D. Mitchell, St. Charles, Mo.

Every gas man in Iowa, Nebraska and South Dakota is expected to attend the meeting.

G. I. VINCENT, Secy. and Treas.

[NOTICE.]

Wrinkle Department, The American Gas Institute.

To the Membership, American Gas Institute: All members of The American Gas Institute, and others interested, are requested to contribute a description of any novel device or scheme covering any feature of the gas business. Every department of every Company uses some novel stunt which would be of value to others. The object of this department is to compile such information. The value of the report depends entirely on the co-operation received. Send in your contribution at once to

MILAN R. BUMP, Editor,
60 Wall street, New York.

BRIEFLY TOLD.

WHAT WILL COME NEXT?—Those dogs (watch-dogs, of course, is meant) who bark for the "peepul" and who rest in the public kennels in Albany and in Manhattan, are roaring at each other in stentorian tones over the lack of legal reasons showing why the Consolidated and other gas companies in New York city should continue to do business therein. The Attorney-General and the Corporation Counsel have instituted measures to put the Companies out of business, and their cross purposes are such that one cannot now write understandingly in respect of the actions. Meanwhile it seems cogent to remark that the two greatest legal officials of the State are playing right well into the hands of those who like to go short of the market—unwittingly, of course, this is being done!

THE JOPLIN MEETING OF THE NATURAL GAS ASSOCIATION.—The second annual meeting of the Natural Gas Association of America, which was held in Joplin, Mo., according to announcement, was in every sense a success. The paper list was a lengthy one and good discussions were the rule. The officers elected were: President, J. C. McDowell, Joplin, Mo.; Vice President, W. H. McKenzie, Kansas City, Mo.; Secretary, J. H. Dunkel, Lawrence, Kas.; Executive Committee, C. W. Sears, E. S. Springer and K. M. Mitchell. Kansas City was selected as the next meeting place, and the banquet (given the night of May 22) was heartily enjoyed.

LIBRARY OF CONGRESS JUN 3 1907 SMITHSONIAN DEPOSIT.

THE PHILADELPHIA SITUATION.—We are indebted to "J. F. W. J.," for the following: "On Thursday, the 23d ult., the sub-committee of Philadelphia City Council's Gas Committee, gave a hearing to the defenders of the gas lease, and Randal Morgan, Vice-President and General Counsel of the United Gas Improvement Company, in a comprehensive statement, showed what has been done in the 9 years during which the Company has had the tenancy of the gas works and an indication of what would be accomplished in the remaining 20 years during which the lease has to run, should the city not choose to terminate the lease at the end of this year. This report showed that the Company has received in the last 9 years an average of 80.4 cents per 1,000 cubic feet for gas. The cry of the opponents of the lease for 'better gas' was answered by the report of Dr. Wiley M. Thomas, Chief of the Bureau of Gas for the 8 years, 1899 to 1907, which showed a minimum candle power of 22.5, the lease calling for 22 candles. The statement of Mr. Morgan was in no sense a plea for the gas lease, but a statement to appeal to the common sense of the community. The opponents of the lease criticized it inasmuch as no statement was made of the cost of gas to manufacture, nor do they seem to appreciate the fact that the cost of gas to the consumer lies within the power of the city itself, and that the rebate which the Company pays is, in a sense, taxes which the consumer pays to the city. That the Company does not receive the dollar, but only 90 cents of it, does appeal to them as a tax by the city on the gas made in its works, and this tax is ever increasing, for from January 1st, 1908, it will be 15 cents per 1,000, from January 1st, 1913, 20 cents, and from January 1st, 1918, 25 cents. This (theoretically at least) comes back to them by the payment to the city. At any rate the Company does not get it. I wrote you in a previous communication that the conservative element was against a change, and this manifested itself when the venerable Mr. Isaac H. Clothier arose and asked to be heard as one of those who had no 'personal or corporate interest in the important matter.' He made a plea to 'let well enough alone,' and said he expressed the views of many 'conservative citizens for the most part who are too seldom heard from in public matters,' but who had written him in ratifying a 'few words of caution' which he had uttered at a City Club meeting. Following Mr. Clothier, Mr. C. Stuart Patterson presented a list of names of gentlemen whose views he represented, and who were opposed to a change in the present gas conditions. This list would certainly, by the amount of capital it represents, make the mouth of a promoter water and his heart beat glad. Among them were: Joseph G. Darlington, of J. G. Darlington & Co., Ex-President of the Union League; George H. Earle, Jr., financier; Isaac H. Clothier and Frederick H. Strawbridge, of the firm of Strawbridge & Clothier; E. T. Stotesbury, of Drexel & Co.; Rudolph Ellis and Effingham B. Morris, Directors of the Pennsylvania R. R.; Geo. H. McFadden, cotton merchant of Philadelphia and London; William D. Winsor, Boston and Philadelphia Steamship Co.; Ralph and Gabriel Blum, of Blum Brothers; Nathan Snellenburg, of Snellenburg & Co.; Samuel D. Lit, of Lit Brothers; Ellis Gimbel, of Gimbel Brothers. The hearing was, therefore, in no sense *ex parte*, but the opponents asked for another hearing which was denied by the Committee, in the midst of wild protestations, and have now issued a public call to the citizens to fight for 75-cent gas and have appealed to the Mayor to hear their story. The Mayor's attitude is strikingly shown in the following dialogue between him and Mr. Walter Wood, Chairman of the Committee of Seven. Mr. Wood said: 'What we want to present is 75-cent gas, Mr. Mayor.' 'That suits me,' was the Mayor's reply. 'Seventy-five-cent gas with as good management as now, and that is high water mark,' added Mr. Justice. 'And that will be a tough job,' rejoined the Mayor."

CURRENT COMMENT.——

MR. A. E. JUDGE, of Tyler, Tex., was re-elected President of the Southwestern Gas and Electrical Association. It was said when he was nominated that the renomination was given him "because of his conscientious and successful labors for the Association." Good.

MR. WM. COX, writing under date of the 27th ult., says: "I trust you will excuse me for calling your attention to the fact that in the formula for the 'Flow of Steam Through Pipes,' page 892, current volume of the JOURNAL, the co-efficient is given as 300, which William Kent says is 'evidently an error,' and this has been corrected in all the latest editions to 87."

AT the adjourned annual meeting of the Denver (Col.) Gas and Electric Company the following officers elected were: Chairman, E. McMillin; President, H. L. Doherty; Vice-President and Gen. Manager, F. W. Frueauff; Vice-Pres. and Gen. Supt., W. J. Barker; Secy., C. N. Stannard; Asst. Secy., A. H. Ostram; Treas., John T. Brady.

The Development of Gasholder Construction.

[A paper read by Mr. GEORGE H. CRESSLER, of Fort Wayne, Ind., at the Milwaukee Meeting of the Wisconsin Gas Association.]

The development of gasholder construction divides itself naturally into three periods of which the lines of demarkation are surprisingly distinct. The first, characterized by uncertainty and experiment, ended with the general adoption of the cylindrical form of holder in 1813. The second, in which the distinguishing trait is the universal use of cast iron, closed in 1882 with the invention of the light steel guide frame. The third period, that of to-day, is signalized by the high degree of exact engineering knowledge that has been attained.

It is probable that Sir James Lowther had the honor of being the first man to store illuminating gas. For we read that in 1733 he carried home in a bag a quantity of the "damp, corrupted air" discovered hissing from a coal pit on his estate, and which burned like a candle. Sixty years later the French physicist Lavoisier, in seeking a method for storing oxygen, perfected the gasometer: a copper bell having inlet and outlet pipes and floating in a tank of water. Accordingly, when shortly after William Murdock was carrying on those experiments that were the beginning of our industry, he found the gasholder ready at his hand. Without this device the application of coal gas to commercial purposes would have been almost impossible. Gasholders, as employed by Murdock and his contemporaries, were rectangular in form, made of heavy plates, strongly braced from within. They were suspended in cast iron tanks by chains passed over beams and heavily counterweighted. Five hundred cubic feet capacity was considered rather large. The deep tanks were considered a source of great difficulty and expense, and the early engineers were soon devising methods of making shallower ones answer. Samuel Clegg was particularly active, inventing two styles of holders to meet the difficulty, neither of which was as successful as ingenious. The first, a rotary holder consisting of an annular vessel which revolved horizontally in a shallow tank, undoubtedly suggested the idea of the station meter. It was succeeded by a collapsible holder, the ingenuity of which was certainly commendable. It was made of light plates, in form like the gabled roof of a house, and opened and closed like the leaves of a portfolio, as the gas entered or was drawn off. This unfortunately was no more popular than the one of rotary form, and the few installed were replaced by the cylindrical holders which now began to come into general use. The question of tanks was still a serious one. Wooden ones were tried, and second-hand vats from the brewers sometimes used. These were quite unsatisfactory, however, as the hoops were liable to come off and the tanks to suddenly burst, causing, as a contemporary remarks, "considerable annoyance."

By the beginning of the year 1815 illuminating gas, through the efforts of Murdock, Winsor, Clegg and their colleagues, was coming to be recognized as a success. Holders became larger and larger until they reached the unprecedented size of 6,000 cubic feet capacity, though in the face of such opposition from those who considered them to be dangerous magazines filled with a high explosive and apt at any time to blow up, scattering death and destruction. The great London Gas Companies were formed and financed. With sufficient means at hand holders were built of continually increasing capacity, and the second period of the development of their construction was well underway. This was marked, first, by a lightening of the containing bells by the removal of a great part of the heavy interior bracing, although the crowns were still heavily trussed and remained so through practically the entire period. The trussing became so massive that one dissenting engineer questioned whether the framework was put in to support the plates or the plates to support the frame. The opinion was freely expressed that the day of untrussed crowns would come, but no one was then so unconservative as to take the responsibility of building one. Flat crowns were occasionally met with, one in particular being made with a low ridge around the outer edge so as to form a shallow tank in which water was to be placed on the theory that the pressure could thus be increased or diminished at will. The fallacy of the idea became apparent the first time it rained, As the demand for greater capacity increased the telescopic principle was evolved and introduced as early as 1840. Two-lift holders were built and were very generally adopted. The 3-lift was looked upon with distrust. As late as 1879 not more than 4 or 5 were in existence, and these "King's Treatise" speaks of as being interesting as an engineering achievement perhaps, but objectionable from their lack of simplicity.

The use of masonry tanks was general, though cast iron was much employed, notwithstanding its great expense. Tanks of very consid

erable magnitude were erected of this material, being built of comparatively small plates, generally ornamented with paneling and beading, bolted together in tiers. Each tier was hooped with a ring of flat bar iron to add to its stability. Steel plate was not greatly favored, and was but little used until a comparatively recent date, except in tanks of annular form, where two concentric rings of steel were employed, the narrow trench between them forming the water box.

The primitive method of supporting the holder in its tank was of course impractical with the holders of large diameters. John Malam, one of the most eminent of the early engineers, devised the system of sustaining the holder by means of a center mast and counterweights.

This arrangement had a very considerable degree of success, particularly for shells of small diameter. A few holders constructed on this principle are still in use. One of about 30,000 cubic feet capacity was built in Fort Wayne, Ind , in the early 50's and was demolished only last year. The logical method, however, is the use of guide framing which seems to have been employed first about 1830. Originally, and for many years, standards, girders and guide rails were made wholly of cast iron. The standards at first took the form of tripods, which soon gave place to massive columns. These were from their great weight practically self-sustaining, the girders being merely tacked on. In accordance with Victorian taste heavy ornamentation was the rule, Girders were decorated with wreaths and festoons. The columns became fluted pillars with Doric capitals, in what has been characterized as an absurd attempt to imitate, in iron, architectural forms originally designed for and applicable only to stone. Occasionally the moulding of the deeply paneled base would be so under-cut, for the purpose of "showing bold," that there would be but little metal left, making the columns weak at the very point where they should have been strongest. In 1869 a column at Limerick thus adorned snapped off in a storm, leveling its own holder and carrying down in the general wreck another holder that was nearby.

Gradually, with the increasing knowledge of strains and stresses, and with the cheapening of wrought iron, there came a change. The cast iron girders, first to go, were replaced by girders of angles with a cast web of open filigree pattern. The latter soon gave way to a net work of heavy lattice bars. During the '70's columns appeared of similar construction. Though they were still of enormous weight they were received with distrust by the more conservative engineers, and the suggestion that they might be somewhat lightened met with great opposition. Their unsightliness, the danger of their rusting and rapidly deteriorating, their apparent frailness and lack of rigidity were disclaimed against. One of the Presidents of the British Association of Gas Managers reminded his colleagues, after a particularly spirited discussion had taken place at their annual meeting, that it should be remembered that cast iron had stood the test of years, and he would still say: "Speak well of the bridge that has carried you safe." And thus the second period of the development of gasholder construction came to an end in the midst of the doubt and uncertainty that had been raised by the growing distrust in the theory of strength from massiveness that had been so generally accepted.

In 1882 Mr. George Livesey, at that time Engineer of the London South Metropolitan Gas Company, read a paper before the English Institute that gave such an entirely new aspect to the whole subject of guide framing that its presentation may have been said to have marked a new epoch in gasholder design. Considering, first, the system of cast iron columns, Mr. Livesey showed that their power to resist a force applied at their tops depended entirely on the strength of the metal at the base of each, the strength of the entire system of course being equal to the strength of each column multiplied by their total number. "It is obvious that the resisting power can be enormously increased by the application of diagonal ties or bracing, as is shown most strikingly in the case of the mast of a ship; thus there is rendered possible a reduction in the weight and strength of individual columns." It must be borne in mind, however, that the use of lateral rollers places a strain upon the columns which the diagonal braces do not absorb. As the columns, therefore, receive the whole of the stress from the gasholder their form should be such as is best suited to resist the pressure of the guide rollers. The upright girder standard (lattice or web-plate column) being strong from front to back is perfectly suited to this service, and hence this form rather than the old cast iron column should be adopted. The entire theory is summed up in the following sentence which is here quoted verbatim from Mr. Livesey's paper: "The diagonal bracing has the effect of converting the series of isolated uprights into a cylinder whose base is equal to the diameter of the tank, usually with a height less than the diameter; and providing the various members composing this cylinder—the uprights, the girders or struts, and the diagonals—are properly proportioned and secured, and of sufficient strength, it must stand as firm as a rock. You have in fact one column say 160 feet in diameter in the place of 16 separate columns each of about 3 feet 6 inches in diameter."

The above abstract from Mr. Livesey's paper is of necessity fragmentary and insufficient. The careful study of the original will well repay anyone interested in this subject. It constitutes an actual contribution to knowledge, and the development of the principles set forth in it has not only made possible the 12½ million cubic feet capacity holder at East Greenwich, but also has assured to the manager of the smallest plant a holder designed on absolute and correct engineering principles. Its postulates have been furthered and developed by a distinguished body of engineers in America and Europe, making possible the flying lift and the unprecedented achievements in spiral and cable guiding. In practical construction the "hit-or-miss" methods have entirely disappeared. There is no need to employ intuition, "a thing to be suspected and shunned in works of construction with iron and steel." In the words of a celebrated English engineer the gasholder design is now studied scientifically, and is not merely a matter of addition, or of copying, or even of fancy." The gas managers of to-day have the certain assurance that every particle of material entering into the construction of a modern holder has its place because of an unchanging principle of engineering, and that every plate, structural and rivet, plays its assigned part in making for strength, durability and efficiency.

[Prepared for the JOURNAL.]

Accidents with Gas Engines Due to Belts.

By "R."

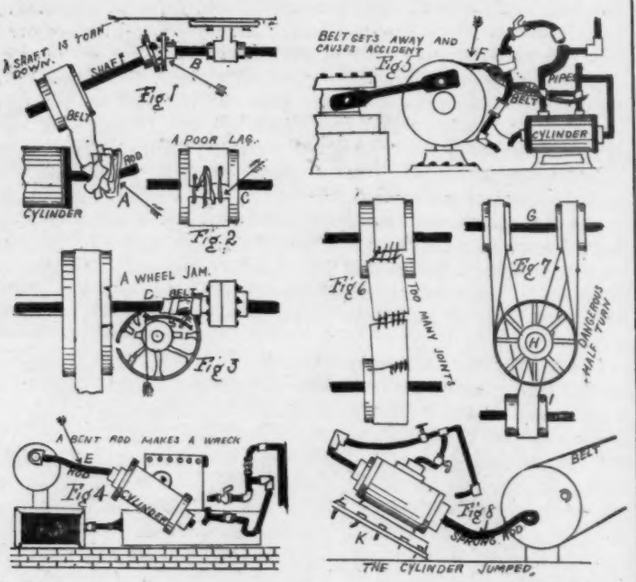
Going into a shop the other day where they were using a gas engine for power purposes I observed quite a complicated tangle of things. One end of the driving belt was wrapped about the rod of the gas engine cylinder, while the other end of the belt was on the driven wheel above, wound in such way that the wheel and the shaft were strained and pulled partly down as shown. It seems that the uncertain, flapping, driving belt had run off from the balance wheel rim while the engine was running at high speed. The belt then caught in at the moving rod and became entangled there as shown at *A*. The momentum given to the driven shaft and wheel above was ample to make the wheel turn enough to grip the belt, tear itself from its fastenings, with the shaft and hangers, breaking open the coupling at *B*. Accidents of this character do not happen very often, but do occur often enough to make gas engine users wary. The usual high speed of the gas engine belt should make it plain to all that extra precautions should be taken in the designing and running of the driving belt, yet in passing through establishments where gas engines are employed one may see divers causes for belts running off from the balance wheels and wrecking the plant by tearing down the shafting at that section. The average belt on the drivers of the gas engine is strong and wide, and it often wraps the shaft and makes things move from below. I have seen small engines lifted up by the flywheel belt wrapping the shaft above.

In the case illustrated in the drawing, Figure 1, the belt was permitted to run in a very wabbly condition. It was too loose, badly sewed at the joints, and exceedingly dry for lack of a softening dressing. Therefore, when the strain became too great and the wheels slid within the belt, the belt ran off the lower or balance wheel. The belt remained on the upper wheel and was snapped about with a snakelike movement until it caught the cylinder rod, then things moved as shown.

In another case an accident occurred to a gas engine because someone made a leather lag for a pulley with the butts of the leather open fully 2 inches as at *C*, Fig. 2. Every time the belt struck the open place it was given a shock. Finally the belt laces freed themselves to the extent of catching on some other laces in the running belt. The long laces needed for reaching across the gap in the lag were drawn out and in the tangle which followed the belt was wrapped about the shafting, as shown at *D*, Fig. 3. The result was that the strain on the wheel below caused the wheel to break away from the shaft and draw up tight to it with a crash. This resulted in breaking in the rim of the wheel as shown. Wheel jams of this character are dangerous and can only be avoided by careful examination of the belting systems of speedy gas engines. Sometimes a power user exchanges his moderately speeded engines for high speeded gas engines. The same shafting, hangers, wheels and belts are used. While these were suitable for the slower moving engine, they fail to meet the requirements of the faster engine.

Sometimes the shafting, the wheels and the hangers get the benefit of the change, and a number of belts are put out of commission before the thing is settled down. The other day I witnessed the consequences of a change of this character; but, instead of the power system getting broken up as usually happens, the gas engine itself was unduly strained. The rod *B*, Fig. 4, proved a weak point in the particular type of engine, and this succumbed by springing as shown. The momentum gathered by the revolving of the tiers of speeding shafts and wheels in this mill jerked the engine severely and tore the cylinder from its fastenings, resulting in the breaking open of some of the pipe connections.

I saw a rather odd combination of twisted pipes and rods in a shop not long since, a sketching of which is given in Fig. 5. The whole trouble was due to the neglect of the workmen in examining the driving belt of the balance wheel of the gas engine. In many of the modern types of gas engines the driving belt is run directly on the balance wheel, as is known, thereby saving the running of one wheel additional for the belt. In this instance the workmen had neglected the main driving belt to the extent of letting it get loose on the wheels, open at some of the lacings, and gummed on the face of the belt. These three factors could have been eliminated during the short stop for dinner; but they were let go day after day, until suddenly the belt lace opened in the driving belt, and the ends flew in and about a system of unprotected piping. The belt wrapped its ends about these pipes like a snake about a victim. The engine kept moving just the same, and, with the belt power gone, the speed increased proportionately until the governor changed to the new condition and eased things off; meanwhile, the flapping ends of the broken belt were getting in their work. The result of the conflict is displayed in Fig. 5. The belt is shown at *F*, flapping off into the network of piping. This piping was torn about in a most through manner and had to be entirely replaced before operations could be resumed. Some men are so careless in the care of their belts of gas engines that they will let one run with many pieces sloppily put together, as illustrated in the many jointed belt in Fig. 6. You cannot expect even and good work with a belt of this makeup. As the laces will slip and bother the belt cannot run steadily, I would discard it and replace it with a new one. Nor would I run a belt as in the plan shown in Fig. 7 for the sake of getting a shaft at another angle from the driver. This combination was installed by a non-thinking man to use for transmitting the power of a new gas engine around a corner as he said. He wanted to get a belt moving on a shaft at right angles with the shaft driven by the engine—the letter *I* shows the driver on the gas engine shaft. This man carried the belt up over the 2 wheel on shaft *G*, thence down to the wheel on the shaft at the right angle *H*. Everything went well for a few days, until the inevitable happened, and our party found his gas engine looped up at the rear end with a sprung piston rod *J*, in Fig. 8. The entire cylinder was

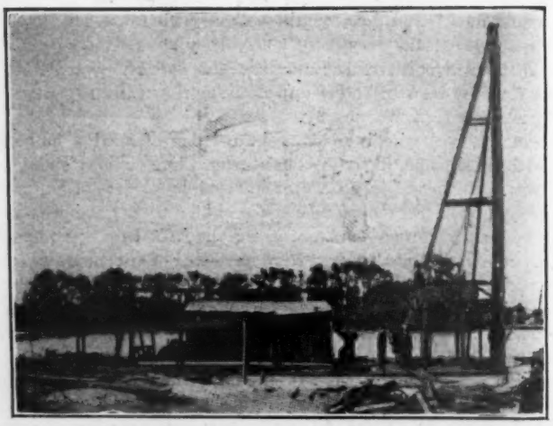


raised from its base *K*. It seems that the upper countershaft was not very powerfully fixed in place. It fell on the cross angle proposition after a time and the moving engine did the rest with the belt of the balance wheel, which ran off and strained the rear of the engine to the extent of lifting the cylinder and base from the foundation.

You cannot fool with the modern, high-speeded gas engine the way we used to trifle with the cumbersome water wheels and slow engines; you must have things in trim when you use a fine caliber gas engine. It is well that it is so because of the fact that the mechanical department of manufacturing plants, and wherever gas engines are used, strive to get the entire power system as near correct as possible, so as to acquire the best results with the finely adjusted and effective gas engine.

Pneumatic Pipe-Dredge.

A correspondent in Sacramento, Cal., writing under date of May 22d, incloses a copy of the Sacramento *Union*, which had this to say respecting a pipe-dredge that is being very successfully used in reclaiming lands more or less under water alongside the Sacramento and San Joaquin rivers. The apparatus is described as a "bed-rock pneumatic pipe-dredge, which, instead of sucking up sand from the surface of the bed of the river as in the ordinary suction dredge, or bringing up the sand in buckets or shovels, its pipe "jets" its way through the sand at the bottom of the river to bed-rock and lifts the material from there or from any point between the river bottom and bed-rock. The sand is lifted through the discharge pipe by use of compressed air and water, which are forced from above down several small pipes surrounding the large central discharge pipe into a mixing chamber. The resulting mixture of compressed air and water is then discharged from below



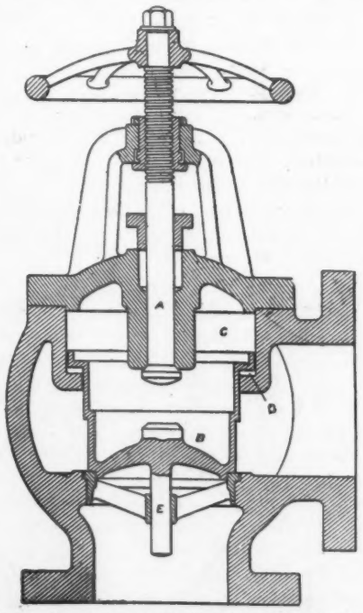
into the larger pipe and creates a vacuum at the bottom of the pipe, with the result that the surrounding sand is drawn into the vacuum and forced up through the pipe. In the test made last week the material raised consisted of over 40 per cent. of sand.

So successful was the demonstration and so great the quantity of sand raised in proportion to the amount of water that old river men, who have been paying out money all their lives for the building and repairing of levees around their farms, were astounded, and they heralded the new dredge as the salvation of the farming interests in the valleys of the Sacramento and San Joaquin rivers. For the dredge had demonstrated not only that it could lift sand from the very bed-rock of the river at any depth—lift it to any required height above water level and the levees, and discharge it wherever required at a cost considerably lower than any other type of dredge now in use—but it also demonstrated that it could select the materials with which to build levees by bringing up coarse sand and gravel from one stratum of the river bed for the foundation of the levees and the lighter silt for the top covering of the levees from another stratum. The pipe was entirely under control and was raised and lowered at will through the various strata. Furthermore, the cost of constructing the dredge is so small compared with other dredges, and its capacity is so great, that in comparison with the $30,000,000 damage caused by the river floods this year, only a small sum would be required to place a chain of these pneumatic dredges at work up and down the river. This would not only build substantial levees and reclaim lands all along the river, but also clean out the river channels and restore navigation to the standard of 1849, at which time boats went up. The pipe can go directly to the bed-rock of the old river channels, prospect for the gold values and bring the sand containing the gold to the surface without first removing the many yards of valueless material and bowlders that overlie the auriferous gravel and black sand. In this way the gold values can be

recovered from the river bed while the sand removed can be used in levee building and reclamation work.

The Anderson Cushioned Type B Nonreturn Valve.

Very heavy nonreturn valves of the Anderson cushioned type B nonreturn "Life and Property Insurance" valves, are being manufactured by the Golden-Anderson Valve Specialty Company. The form of construction and the materials thereof are chosen to adapt the



The Anderson Type B, Cushioned Nonreturn Valve.

valve to the highest steam pressures in commercial use, and render it free from chatter, hammer or tendency to stick, and to make it positive in case of accident.

These valves when placed between the boiler and header will equalize the pressure between the different units of a battery of boilers, as they remain closed as long as the pressure of the boiler is lower than that in the header. When the two pressures are equal the valves will open and remain so without chattering or hammering. They will automatically cut off a boiler in case of accident to that boiler, such as the bursting or collapsing of a tube, and will also act as a safety stop to prevent steam being turned into a cold boiler, which also means a safeguard for men working inside. It is worthy of note that more lives are lost owing to what may be termed minor accidents than result from actual boiler explosions.

A large part of accidents of this character result directly from scalding, owing to the escape of steam and water, which makes it difficult, in many cases impossible, to approach the stop valve. For this reason it is desirable to take all possible precaution to insure safety. Boiler attendants are many times deceived by inaccurate steam gauges, and are likely to turn on steam and connect the boiler when there is considerable difference in pressure. Many accidents have resulted from this cause.

As a protection against such accidents the Anderson cushioned nonreturn valve is offered. It is an automatic stop valve and a hand stop valve at the same time, so that it may be used instead of the regular angle, globe or gate valves at the boilers. Very often these can be substituted without changing the piping at the boilers.

Referring to the sectional view, the inferior arrangement for cushioning the valve to avoid chattering, hammering and sticking will be understood. The piston or valve is one bronze casting, which may be likened to a Corliss dash-pot. It occupies the full area of the upper portion of the body, thus insuring a perfect cushioning in the opening and closing of the valve, and the perfect alignment of the valve with the seat at all times, irrespective of the position. When the steam pressure raises the valve the large dash-pot above the valve acts as a cushion, and the steam being always under the valve wing at *D*, cushions the valve when closing. The two actions prevent chattering. The extension at the bottom of the valve acts as the first cut-off or throttle against the effects of the wire drawing of the steam.

The Introduction of Electricity into Damascus.

Two years ago most people even in Turkey scoffed at the idea of electric lighting and traction being introduced and actually established in Western Asia. The Damascus-Mecca railway scheme was greeted with derision or at least with profound scepticism. However, even then to the careful observer there were signs—and these are gradually multiplying and becoming more pronounced—that the dawn of a great awakening is slowly coming in the near East. Electricity has been admitted into the Turkish Empire. The American Consul-General at Beirut says that he recently visited Damascus, and saw overhead trolley cables in the streets, and a few miles up the Barada river the station erected for the generation of electric motor power.

Damascus, the oldest surviving city in the world and the most typically Oriental one in the Turkish dominions, leads in Turkey in adopting electricity for purposes of light and locomotion. The harnessing of the Barada for such ends emphasizes the change which is fast overtaking Ottoman industrial and social life. On February 7, 1907, Damascus celebrated an inauguration of more than passing interest. In the presence of the Governor-General of the province and the General in command of the 5th army corps, besides the civil and military officials, notables of the city and foreign consuls, on that day the new electric street cars and street lighting service in Damascus were handed over by representatives of the Ottoman government, who had come from Constantinople for that purpose, to the Societé Ottomane Impériale des Tramways et d'Eclairage Electrique de Damas. It was a red-letter day in the annals of Ottoman Asia. At first the street service will cover only the distance from Salhyeh to the Meidan, some 5 miles through the city from suburb to suburb.

Cars were to commence running on March 14th on which day the Ottoman fiscal year begins. Electric lights have been installed, and Damascus is now being lighted by 1,000 electric street lamps for which the municipality pays an annual rental of $13,750. Besides these the company have put in more powerful lights in the Grand Mosque, in the public squares, and in the Serail. Private electric lights are soon to be introduced in shops and residences. The installing company is Belgian. Some of the electrical supplies and apparatus have come from England, Germany, and France, but all cars, motors, dynamos, etc., have been bought in Belgium. Concessions for electric lighting and street railway undertakings have been granted to corporations in Damascus, Beirut, Aleppo, Smyrna, and Salonica. So far nothing has been heard of the authorization of telephone companies.

Steam in Gas Producer Practice.—An Investigation on the Use of Steam in Gas Producer Practice.[1]

By W. A. Bone, D.Sc., Ph.D., F.R.S., Professor of Applied Chemistry (Fuel and Metallurgy), Leeds University; and R. V. Wheeler, M.Sc., late Dalton Scholar and Research Fellow of Manchester University; Chemist to Messrs. Monks, Hall & Co., Ltd., Warrington, England.

The experiments recorded in this paper were carried out during May and June of last year with a gas producer plant at the iron and steel works of Messrs. Monks, Hall & Co., Limited, Warrington, with a view to determine the influence of variation in the proportions of air and steam in the blast upon the composition of the gas, its suitability for furnace operations, and upon the general and thermal efficiencies of the producers. The investigation caused a series of five trials, each extending over a full working week, with the plant supplying washed gas both for gas engines and for re-heating and puddling furnaces, all working under normal conditions. The only difference between the conditions from week to week was in the relative proportions of steam and air used in the blast for the producers, which were varied by raising the steam saturation temperature of the blast, in five equal stages, from 60° to 80° C. As will be explained later, arrangements were made for the accurate determination of every possible factor in the results which would be influenced by the variations in the working conditions at the producer. The results as a whole may, we think, be considered as establishing reliable data, not only as to what a gas producer is capable of doing under scientific supervision and control, but also with respect to the maximum of advantage and efficiency derivable from the use of steam between the above-named limits.

The objects of the experiments will be, perhaps, better understood if we preface an account of them by a brief consideration of the chemical and thermal changes involved in ordinary gas producer practice, where a bituminous coal is primarily decomposed and the resulting coke subjected to the combined action of air and steam at high temperatures.

1. Paper read before the Iron and Steel Institute, May 10, 1907.

When a charge of coal is dropped into the producer, it first of all undergoes a process of destructive distillation similar to that carried out in the manufacture of coal gas. The products of distillation are, chiefly, hydrogen, methane, tarry hydrocarbons, and carbonic oxide, together with small quantities of ammonia, compounds of sulphur, and a large residue of coke. A ton of good gas coal, when distilled in a retort, yields approximately 10,000 cubic feet of gas, comprising 5,000 cubic feet of hydrogen, 3,500 cubic feet of methane, 700 to 800 cubic feet of carbon monoxide, and some 500 cubic feet of ethylene and heavy hydrocarbons, as well as about 1 cwt. of tar and 5.8 pounds of ammonia (= 22.5 pounds of ammonium sulphate). Under the conditions of ordinary producer practice the relative yields of these "distillates" are probably much the same as in the gas retort, except that ethylene and other olefines are decomposed in the producer, and do not, as a rule, appear in the gas. Moreover, the addition of steam to the air blast is probably without material influence on the distillation, except in so far as it may, under suitable conditions, produce a marked increase in the yield of ammonia.

The incandescent coke, arising from the primary distillation, is in turn gasified by the combined action of oxygen (air) and steam in what is sometimes termed "the zone of partial combustion." The blast is usually preheated during its passage through the layer of hot ashes upon which the unburnt fuel rests. The efficient management of the producer mainly depends on a proper understanding of the chemical aspects of this part of the process. It is necessary, then, to consider:

1. *The Action of Oxygen (Air) upon Incandescent Carbon.*—There is still considerable difference of opinion amongst chemists as to the mode of combustion of solid carbon. The commonly accepted view is that carbon burns directly to carbon dioxide, which, in contact with an excess of incandescent carbon, is immediately reduced to carbon monoxide, thus:

$$(a)\ C + O_2 = CO_2, \text{ and}$$
$$(b)\ CO_2 + C = 2CO.$$

This view is, however, unsupported by any conclusive evidence, and is difficult to reconcile with Mr. H. B. Baker's classical experiments on the combustion of solid carbon.[1] Moreover, the work of Professor H. B. Dixon and his pupils on the rates of explosion of mixtures of cyanogen and oxygen, corresponding to $C_2N_2 + O_2$ and $C_2N_2 + 2O_2$ respectively, leaves no room for doubt that gaseous carbon burns in two well defined stages—viz. (1), directly to carbon monoxide, $C_2N_2 + O_2 = 2\,CO + N_2$, and (2) with a sufficient supply of oxygen the carbon monoxide is subsequently burnt to carbon dioxide, $2\,CO + O_2 = 2CO_2$[1].

Taking the whole of the known facts into consideration, we are of the opinion that the balance of evidence is in favor of the view that solid carbon, like cyanogen, burns directly to carbon monoxide—

$$(c)\ 2C + O_2 = 2CO,$$

and that carbon dioxide is only formed by the secondary combustion of the monoxide,

$$(d)\ 2\,CO + O_2 = 2\,CO_2.$$

It is, perhaps, hardly necessary to say that, whichever of the above views of the mode of formation of carbon monoxide be adopted, the thermo-chemical aspect of the question would not be affected. When solid carbon is burnt to carbon monoxide, as nearly as possible 30 per cent. of its total heat of combustion is generated. Thus we may write:

$$\left.\begin{array}{l} 2\,C + O_2 = 2\,CO = 2 \times 29 \\ \text{and } 2\,CO + O_2 = 2\,CO = 2 \times 68 \end{array}\right\} \text{kilogramme C. units.}$$

The large amount of heat so generated in the burning of the carbon to carbon monoxide would, if not in part absorbed in decomposing steam, give rise to inconveniently high temperatures in the producer, with consequent clinker troubles and other practical difficulties. The use of steam in the blast, however, allows of part of this heat being at once utilized in doing chemical work in the producer, and thereby raising the potential energy of the resulting gas at the expense of some of its sensible heat. This brings us at once to the consideration of:

2. *The Action of Steam upon Incandescent Carbon.*—The composition of the gas obtained when steam reacts with solid carbon depends mainly upon the temperature. At comparatively low temperatures (about 500° to 600° C.) the chief products are carbon dioxide and hydrogen, in accordance with the equation:

$$(e)\ C + 2\,H_2O = CO_2 + 2\,H_2 - 19 \text{ kilogramme C. units; steam,}$$

whereas at temperature of 1,000° C. and upwards the main reaction involves the production of equal volumes of carbon monoxide and hydrogen (water gas), in accordance with the equation:

$$(f)\ C + H_2O = CO + H_2 - 29 \text{ kilogramme C. units, steam.}$$

At temperatures between 600° and 1,000° the products correspond to a simultaneous occurrence of *e* and *f*, the second reaction gradually asserting itself as the temperature rises, until at 1,000° it entirely supersedes the first.

Both reactions are, however, endothermic, the first named representing the disappearance of 19, and the second of 29.2 kilogramme C. units of heat, and consequently both operate in reducing the temperature in the producer and in raising the thermal efficiency of the system. It is clear, also, that *ceteris paribus*, the second reaction will be more effective in this respect than the first.

It may here be remarked that when an excessive amount of steam is employed—for example, in the Mond system, where ammonia recovery is one of the chief aims of the process—the temperature in the producer is low enough to allow of a considerable occurrence of reaction *e*. This probably accounts for the relatively high percentage of carbon dioxide in Mond gas. But where ammonia recovery is not aimed at, the maximum practical efficiency is attained when this reaction is as far as possible excluded.

It seems useless to discuss what would be the maximum theoretical efficiency obtainable with an ideal producer, consisting of a self-contained system, in which the whole of the heat developed by the burning of the carbon to carbon monoxide by atmospheric oxygen is utilized for raising the steam, and effecting its decomposition entirely in accordance with the equation $C + H_2O = CO + H_2$, including the maintenance of the requisite high temperature in the bed of fuel. Such conditions would be entirely hypothetical and have no relation to actual practice. Moreover, the calculation would involve certain arbitrary assumptions, which need not here be specified. It will be more profitable to consider, in the light of the results recorded in this paper, how far the undoubted advantage involved in the use of steam can be pushed in practice.

2. *Influence of the Reversible Reaction* $CO + OH_2 \rightleftarrows CO_2 + H_2$.—This survey of the chemistry of gas production would be incomplete without a reference to the interactions between the oxides of carbon, hydrogen and steam in the producer. At all temperatures above 500° C., or thereabouts, steam reacts with carbon monoxide, and hydrogen with carbon dioxide, the two reactions constituting a reversible system.

$$CO + OH_2 \rightleftarrows CO_2 + H_2.$$

At any given temperature, the amount of change in each direction in the unit of time (or, in other words, the velocity of the change in each direction) depends on the relative masses (concentration) of the reacting gases, in accordance with the law of "mass action." Ultimately a condition of "dynamic equilibrium" is set up, when the velocity in one direction is exactly balanced by the velocity in the reverse direction. This condition of equilibrium depends also on the temperature, but for any given temperature may be defined in terms of the "active masses" (*i. e.*, concentration), of the gases concerned. Thus, at each particular temperature the product of the concentrations of the carbon monoxide and steam (expressed in percentage volumes)—*i. e.*, $CO \times OH_2$—bears a constant ratio to the product of the concentrations of the carbon dioxide and hydrogen—*i. e.*, $CO_2 \times H_2$—when equilibrium is established. Oscar Hahn[1] has recently determined the equilibrium ratios for a series of temperatures between 786° and 1,405° C., as follows:

Temp. Deg.	$\frac{CO \times OH}{CO^2 \times H}$ = K.	Temp. Deg.	$\frac{CO \times OH}{CO_2 \times H_2}$ = K.
786	0.81	1086	1.95
886	1.19	1205	2.10
986	1.54	1405	2.49

whilst H. B. Nixon, who was one of the first accurately to investigate the question, found the value of K to be 4.0 for the much higher temperatures of explosion flames.[2]

These data enable us to predict both the direction in which change (if any) will take place in a system containing oxides of carbon, hydrogen, and steam, and also the final state of equilibrium at any given temperature, provided their relative concentrations are known. Moreover, it is obvious (1) that in the case of a given mixture which is an equilibrium at a low temperature (say 800°), change will take place in the direction $CO_2 + H_2 = CO + OH_2$ as the temperature is raised, and *vice versa*, and (2) that the addition of steam at any tem-

1. *Journal of the Chemical Society* (*Transactions*), 1896, vol. lxix, pages 759, 774; also *ibid.*, 1899, vol. lxxv., page 690.

2. *Journal of the Chemical Society*, 1885, Vol. XLV., page 349; also Philosophical Transactions of the Royal Society, 1888, Vol. CLXXIX., A., page 571.

1. *Zeitschrift fur Physikalische Chemie*, 1903, vol. XLIII., page 705; vol. XLIV., page 513.

2. Philosophical Transactions of the Royal Society, 1884, Vol. CLXXV., page 6.7.

perature will tend to cause change in the opposite direction. Finally, it may be remarked that the change in the direction $CO_2 + H_2 = CO + OH_2$ involves an absorption of heat, whilst change in the opposite direction involves a corresponding evolution of heat.

4. *Influence of the Reversible Action $C + Co_2 \rightleftarrows 2\ CO$.*—The relative proportions of carbon monoxide and dioxide in the resulting gas are are also, to some extent at least. influenced by the reversible change,

$$(8)\ C + CO_2 \rightleftarrows 2\ C0.$$

According to O. Boudouard[1] the following mixtures of carbon monoxide and dioxide are in equilibrium with solid carbon, under atmospheric pressure, at temperatures of 650°, 800°, and 925° C. respectively.

Temperature. Degrees.	Percentages of CO	CO_2
650	39	61
800	93	7
925	96	4

At higher temperatures than 1,000°, the percentage of carbon dioxide remaining when equilibrium is established is probably extremely small. Clearly, therefore, this pair of reversible actions, like those discussed in the preceding paragraphs, tends to increase the percentage of carbon dioxide in the resulting gas when the temperature of the zone of reaction in the producer is lowered by the use of steam in the blast, and *vice versa*. But to what relative extent each of the various reactions under discussion is operative in this respect in actual practice can only be determined by further investigation, which, in view of the importance of the subject, is urgently needed.

From the foregoing paragraphs it is clear that both the efficiency of the producer and the composition of the resulting gas will, *ceteris paribus*, be largely determined by the relative proportions of steam and air in the blast, not only because of the operation of the principle of mass action, but also on account of the fact that the temperature of the bed of fuel—*i. e.*, the temperature at which the various reactions proceed—depends on the amount of steam employed. Obviously the use of steam is limited by the consideration that a certain fairly high temperature must be maintained in order that the gasification of the fuel may proceed at all; but this limit is rarely approached in practice, and need not be considered here.

But the employment of steam is not solely determined by considerations of "efficiency" or on other chemical grounds. A certain proportion of steam is used to reduce clinkering troubles to a minimum. The amount so required depends principally upon the character, and, to some extent also, on the amount of the ash in the coal used. Our experience of Lancashire coals, for instance, leads us to believe that the percentage of lime in the ash, *ceteris paribus*, has a marked influence upon its fusbility, and hence on the liability to clinker in the producer. It may be of interest if we reproduce here the analyses of the ashes of five Lancashire bituminous coals in order of their fusibilities, commencing with the most fusible.

Analyses of the Ashes of Lancashire Bituminous Coals.

Name of Seam.	1. Wigan 4 Feet. Per Cent.	2 Florida. Per Cent.	3 Arley. Per Cent.	4 Wigan 6 Feet. Per Cent.	5 Trencher-bone. Per Cent.
SiO_2.....	31.40	30.02	26.40	33.80	39.40
Al_2O_3.....	21.15	19.14	28.00	21.75	28.49
Fe_2O_3.....	22.85	22.14	32.42	29.30	22.85
MnO.....	0.55	0.65	Nil	Nil	0.40
CaO.....	16.25	11.10	7.00	3.00	4,30
MgO.....	0.10	3.65	2.88	3.24	1.08
SO_3.....	7.00	13.29	2.74	8.58	3.26
P_2O_5.....	0.11	0.15	0.28	0.15	0.17

The most fusible ash was that of No. 1 coal from the Wigan 4-foot seam, which, it will be observed, contained the highest percentage of lime. The fusibilities decrease from left to right of the table, the No. 5 coal (Trencherbone) containing by far the least fusible ash.

Description of the Plant Used for the Trials.—The two producers selected for these trials were of the well-known Mond type. They were erected in 1903 as the first instalment of the gas plant at the works of Messrs. Monks, Hall & Co., Limited, Warrington, for the supply of washed gas to their re-heating and puddling furnaces and gas engines. The Mond producer was admirably adapted to the purpose of our investigation, for two reasons—viz. (1) the superheating of the blast not only renders the use of a large proportion of steam possible, but (2) it also insures the perfect admixture of steam and air, in easily regulated proportions, before the blast reaches the incandescent fuel. It must be clearly understood, however, that the object of our investigation was not the testing of the efficiency of the Mond system as such, but rather to determine how steam may be used to the best advantage in a producer, having regard to the quality and composition of the gas, and its suitability for furnace purposes. Indeed, as will be shown later, the working conditions in the plant during the trials differed in important respects from those under which a Mond plant is usually operated, and in only one of the five trials did the steam saturation temperature of the blast approximate to the Mond practice. Another consideration which must be borne in mind is that no ammonia recovery was attempted, although careful estimations were made from day to day of the ammonia actually present in the gas during the trials. Indeed, the rate of gasification (74 to 93 tons of dry coal per week) did not allow of ammonia recovery being profitably undertaken. The general design of the producers and arrangement of the washing plant will be readily understood from the figures.

Fig. 1 shows the vertical section through the middle of the producer.

Figs. 2 and 3 show the front and end elevations respectively of the plant.

Fig. 4 shows the general plan of the plant.

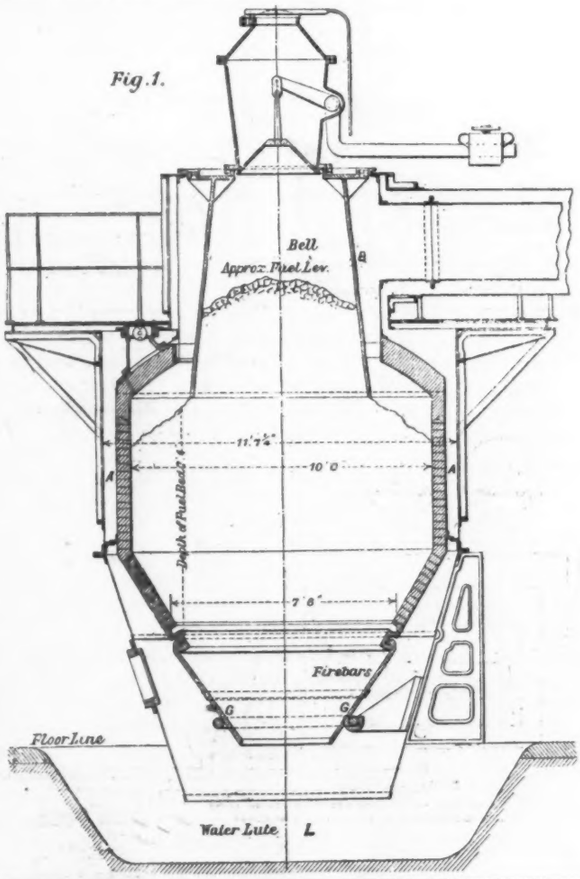
Figs. 5 to 8, inclusive, show the direction of the gases through the plant.

Figs. 9, 10 and 11,[1] show the general arrangement of the plant from various positions.

The two producers were of the water-bottom type, and consisted of an inner shell (the producer proper), constructed of mild-steel plates lined with firebrick, and incased within a similar outer shell. The air and steam composing the blast passed through the annular space (5 in.) *A A* (Fig. 1) between these two shells before entering the producer below the fire-bars *G*. The lower part of the producer was conical in shape, and extended downwards into the water-lute.

The large cast iron bell *B* maintained a constant fuel level in the producer of about 14½ feet above the fire-bars, and also assisted, to a certain extent, in the preliminary dry distillation of the coal. The products of this distillation had, moreover, to pass out at the bottom of the bell and through the hot fuel in the body of the producer before reaching the gas exit into the superheaters outside. It is generally supposed that this arrangement brings about the decomposition of a portion of the tarry products of the distillation, but, in our opinion, its value in this respect is somewhat doubtful.

Fig. 1.



1. *Annales de Chimie et de Physique*, 1901, Series VII., Vol. XXIV., pages 28 to 34.

1. 11 will be shown next week.

Fig. 2

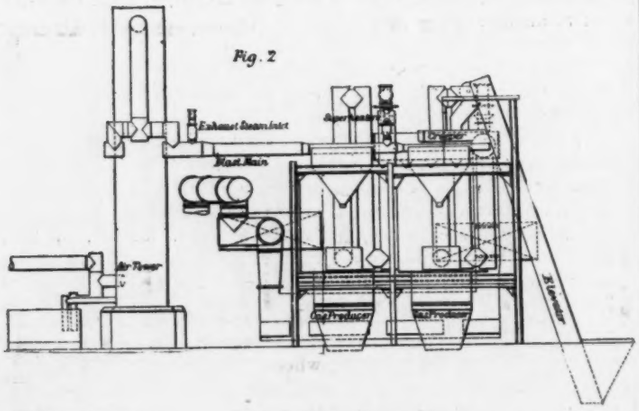


Fig 3

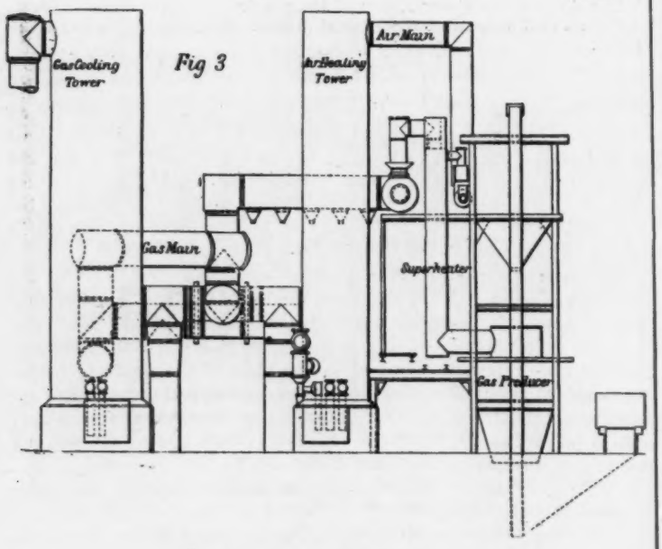


Fig. 4.

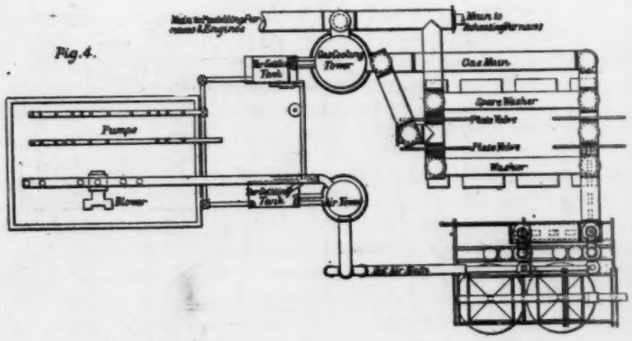


Fig. 5.

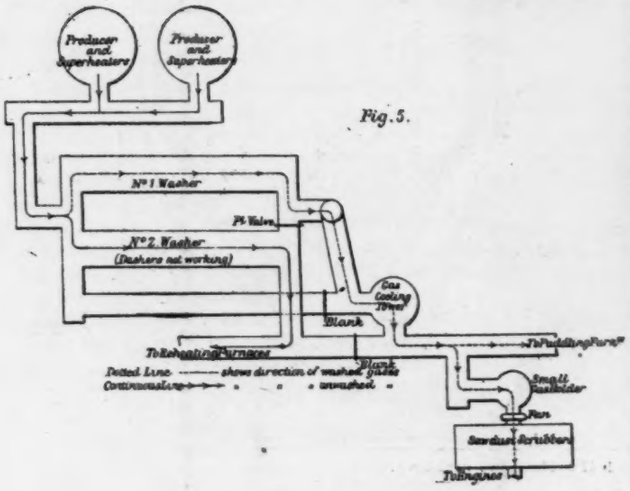


Fig. 6. AVERAGE PRESSURE BENEATH FIRE BAR GRATE OF PRODUCER

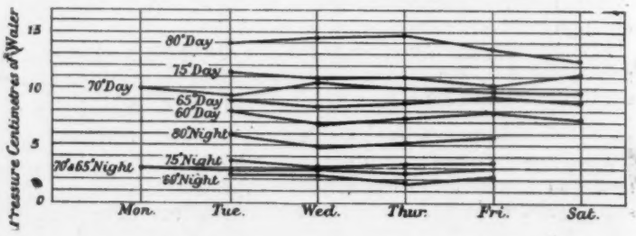
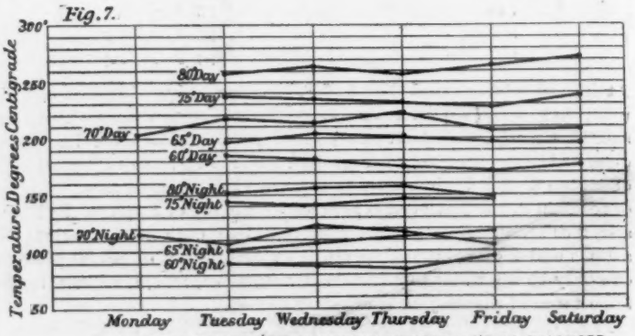
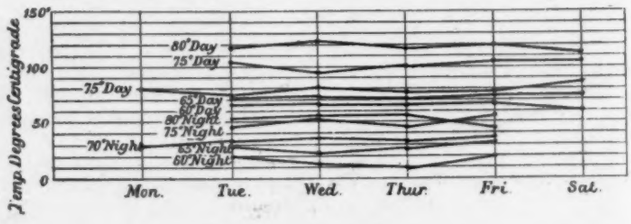


Fig. 7.



AVERAGE TEMPERATURE LEAVING SUPERHEATER OF PRODUCER

Fig. 8. AVERAGE TEMPERATURE OF GASES IN FURNACE MAIN



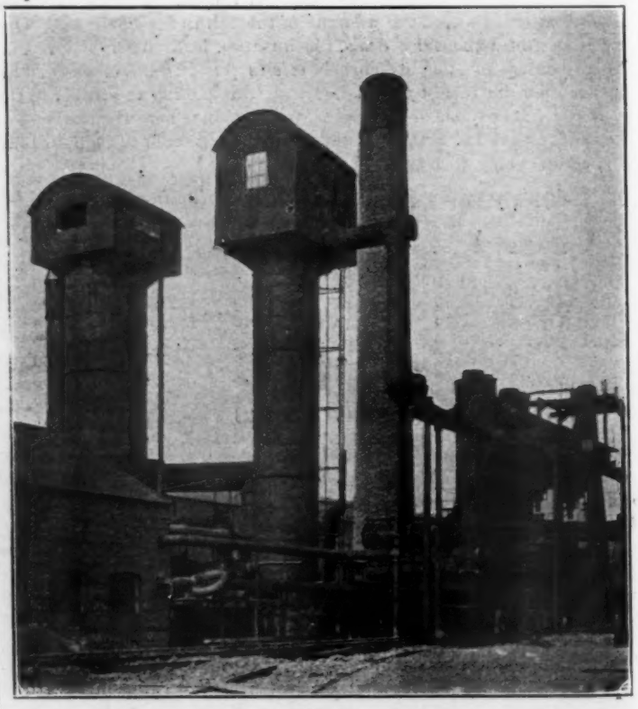


Fig. 9.

On leaving the producers, the hot gas passed through the superheaters (Fig. 2 and 3), round which the air and steam forming the blast travelled, in the reverse direction, through the annular space between the inner gas main and the outer jacket. In this way part of the sensi-

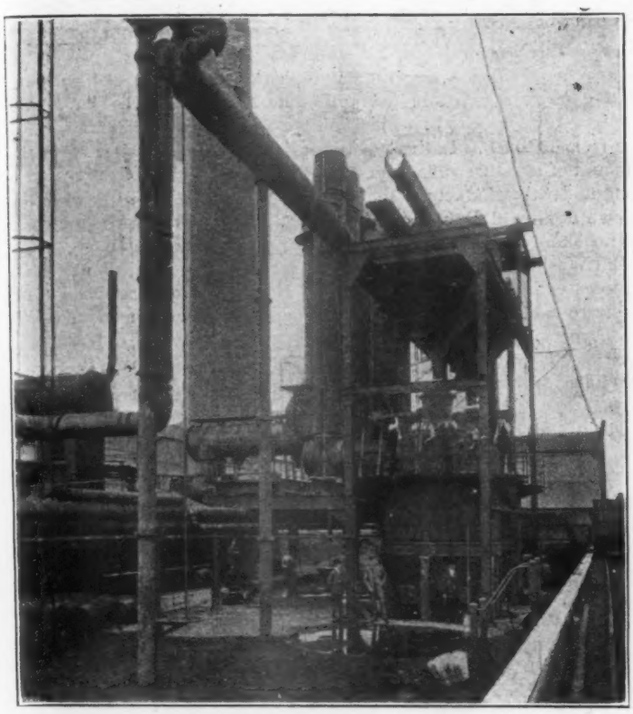


Fig. 10.

Mond Gas Plant at the Works of Messrs. Monks, Hall & Co., Ltd. (Figs. 9-10.)

ble heat of the gas was transferred to the blast, the temperature of the gas leaving the superheaters during the day-shift ranging from about 180° to 260° C. as the steam saturation temperature of the blast was raised from 60° to 80° C. From the superheaters the gas passed through the rectangular iron washers (Fig. 4), where it met with a fine spray of water thrown up by revolving dashers.[1] The gas was here partly freed from tar vapors, and further cooled to between 94° and 100° C., according to the steam saturation temperature maintained during the trial. The fact that the gas was required both for furnaces and for engines rendered it desirable to differentiate between the subsequent treatment of each supply. Since the presence of a certain amount of tarry vapors in a furnace gas is rather an advantage than otherwise—not so much, perhaps, because of the increased calorific value (since this is very small) as on account of the fact that the tar vapors render the flame luminous in the furnace—the furnace supply was not washed or cooled, but sent direct to the furnace distributing mains. The engine supply was, however, further cooled to almost atmospheric temperature by being passed up the gas cooling tower, and was finally freed from tarry vapors by passage through sawdust scrubbers. The general direction of the gases through the plant is indicated in Fig. 5.

A notable departure was made from the usual Mond practice during these trials in that no recuperation was attempted in the air blast towers (Fig. 4). In the Mond practice the gas leaving the washers above referred to is passed up the gas cooling tower (containing earthenware tiles), where it meets with a downward stream of water. An exchange of heat between the hot gas and the cold water is thus effected, and the hot water leaving the bottom of the tower is pumped up to the top of the air heating tower, down which it is allowed to fall. During its descent it meets the ascending air blast forced in at the bottom of the blower, whereby another heat exchange is effected, and the blast both heated and charged with steam. In the trials referred to in this paper no water was pumped through either of these towers, since it was found that the temperature of the gas leaving the washers was not sufficiently high to render further heat recuperation valuable; in fact, the consumption of steam for driving the pumps would have outweighed any small advantage derived from the heat recuperation.

The steam used for saturating the air blast during the trials was partly exhaust steam (in the trials at 60° and 65° wholly so) and partly live steam. The various sources of exhaust steam were connected together so as to form a common exhaust steam main, which entered the blast main at its exit from the air heating tower. Any live steam required was obtained by connecting a live steam pipe to the exhaust steam main at a distance of about 30 feet before its entrance to the blast main. The two supplies were thus thoroughly mixed with the air blast during its passage through the superheaters and round the shell of the producer.

The gas was utilized for the following purposes—viz.:

1. Two reheating furnaces in a 10-inch bar mill.
2. One 650-horse power gas engine driving the rolls in this mill.
3. One swarfe furnace, with an output of 3½ tons per shift of 12 hours.
4. One puddling furnace, with an output of 3½ tons per shift of 12 hours.
5. One 250-horse power gas engine generating electricity.

The rated capacity of the two producers corresponded to a gasification of 32 cwt. of coal per hour (16 cwt. per producer); but since the demands for gas during the day-shift, when all the above furnaces and engines were working at full swing, never necessitated a gasification of more than 24 cwt. per hour, it will be seen that the plant was not worked beyond about three-quarters of its rated capacity.

The actual rates of gasification during the trials naturally varied according to the requirements of the furnaces and engines concerned. The rate during the day-shift was always about twice that of the corresponding night-shift. The following statement shows the maximum demands of the various consuming units, in terms of weights of coal gasified in the producer per shift of 12 hours:

	Day-Shift. Tons. Cwt.	Night-Shift. Tons. Cwt.
1. Two reheating furnaces	7 5	2 10
2. One 650-horse power gas engine in mill.	1 15	Nil
3. One swarfe furnace	1 0	1 0
4. One puddling furnace	1 10	1 10
5. One 250-horse power gas engine	2 10	1 10
Totals	14 0	6 10
Rate of gasification per hour	23.3 cwt.	10.8 cwt.
Mean rate of gasification per hour throughout the 24 hours	17 cwt.	

The charging hopper of each producer had a capacity of 10 cwt. of coal, and, under normal working conditions, a charge was added to each producer alternately, once every ½-hour during the day-shift, and once every hour during the night-shift.

We may here incidentally remark that the type of producer used for these trials was, as is well known, originally designed some years ago by Dr. Ludwig Mond, F.R.S., with special reference to ammonia recovery, the quality of the gas produced being of secondary importance.[1] To obtain the maximum yield of ammonia, consistent with the economic working of the process, he found it necessary to "work the producer as cool as was compatible with a good combustion of the fuel," and he obtained "the best practical results by introducing about 2 tons of steam for every ton of coal consumed." This would mean an air-blast saturated with steam at about 85° C. But ammonia recovery can only be profitably undertaken when the fuel consumption exceeds some 150 tons or thereabouts per week. Moreover, the excessive use of steam under such conditions involves the production of a gas relatively rich in hydrogen and carbon dioxide, but poor in carbon monoxide. Thus Mr. A. Rollason[2] has given the following figures relative to the composition of Mond gas from a large plant working with ammonia recovery at the works of Messrs. Brunner, Mond & Co, Limited, Winnington, Cheshire:

	Per Cent.	
Carbon dioxide	= 16	
Carbon monoxide	= 11	
Hydrogen	= 29	Total combustibles = 42.
Methane	= 2	
Nitrogen	= 42	

Such a gas, on account of its relatively high content of hydrogen and poverty in carbonic oxide, is not specially well adapted for furnace purposes. The reason of this is probably connected with the remarkable influence of hot surfaces upon the combustion of hydrogen, recently investigated by us,[3] and we hope, on some future occasion, to lay before the Institute the results of further investigations on the relative efficiencies of hydrogen and carbonic oxide as furnace fuels. For steel making purposes, where ammonia recovery must always be of second-

1. These were purposely worked more slowly than in the usual Mond practice; indeed, the gas destined for the furnaces was simply allowed to skim the surface of the water.

1. *Vide* Dr. Mond's Presidential Address to the Society of Chemical Industry in 1889.

2. "Mond Gas: Its Production and Applications," a paper read at the Glasgow and West of Scotland Technical College Scientific Society in 1901.

3. Philosophical Transactions of the Royal Society, 1906, Series A, Vol. CVIII., pages 1 to 67.

ary importance relatively to the production of steel, a much lower steam saturation temperature than that demanded by Dr. Mond at the producer would seem desirable. It was this consideration which led us to carry out the present experiments.

(To be Concluded.)

The Washington Coal Situation.

By Mr. R. P. Tarr.

Washington, the State destined soon to rank according to population well up in the list of States, contains the measures which must furnish fuel for not only its own demands, but also for those of western Montana, Idaho and Oregon. Within this State are the undeveloped beds, and the only coal areas of importaece in northwestern United States. During the past winter the State was in the throes of a fuel famine, and this has caused a unique situation. There are undeveloped and almost unknown deposits in Whatcom, Skagit, Snohomish, Chehalis, Pacific, Lewis, Cowlitz, Clarke and Skamania counties, and other parts of Kittitas than those to which operations are now confined.

Early Operations.—It was when the earlier efforts were being made to open the coal deposits of Washington that the most serious mistakes occurred, producing adverse conditions now. Besides the knowledge of the existence of coal in certain parts of the State, little was known concerning any area until after the investigations and reports of Bailey Willis, Geologist U. S. Geological Survey (Vol. 15, 10th census). This admirable report, practically confined to the Palmer-Wilkeson fields, directed attention to this region. Into these sections the pioneer of the early 80's made his entrance, wholly unprepared and entirely ignorant of mining methods, eager only to file his claim.

Soon many mines were opened, to be operated only temporarily. Of these there are nearly a score, abandoned monuments of the errors of those who were unacquainted either with coal mining problems, the demands of the time, or with financial requirements of big projects. These failures produced a reaction which placed a discount on the merits of the coal fields in general, and put a quietus to future development by driving away both capital and interest.

When the railroad and steamship companies attacked the problem of mining systematically these difficulties disappeared. The railroads which now contemplate entering the Sound country will probably also achieve success. But there is another problem confronting the State. Along with the railroad development comes increase in population and additional industries. The commercial side of coal development must therefore be considered immediately. The railroads cannot take care of this; outside capital must.

At the present time 30 mines are in operation, about half of which may take ranking importance. The remainder have small outputs and are undergoing every sort of struggle to stagger on. Several of them are reopenings of abandoned properties and owing to former mistakes in mining methods cannot be operated with advantage.

Present Output.—During 1906 the total coal output in the State was 3,290,534 tons. This was an increase of 443,633 tons above that of 1905. Of these 30 mines, 5 are operated by the Northern Pacific Railway Company and produce 44 per cent. of the entire output, 8 are operated by the Pacific Coast Steamship Company and produce 37 per cent. of all coal mined. The remaining 17 mines produce but 19 per cent. of the entire tonnage.

The following analyses show the values of the best types of coal mined for various uses:

	Roslyn, Steam, etc.	Burnett, Gas.	Wilkeson, Blacksmith.	Fairfax, Coke.
Moisture.....	1.91	1.44	1.38	1.30
Volatile matter...	34.30	40.90	21.69	19.22
Fixed carbon.....	51.11	49.24	66.96	64.22
Ash.....	12.68	8.42	9.97	15.26

The coal is mined from three principal fields:

Palmer (Kings county) producing.....	52 per cent.
Roslyn (Kittitas county).....	41 "
Wilkeson (Pierce county).....	7 "

Of the entire output, 66 per cent. is consumed by railroad and steamship companies. The remaining 34 per cent. is used commercially in Washington and tributary territory having a population of 1,250,000 inhabitants.

Character of the Deposits.—The Cascade uplift was very intense, but not to the degree that much metamorphism of the coal measures has taken place. During the uplift four active volcanoes were formed namely Baker, Rainier, Adams and St. Helens. Dikes from these have considerably broken the measures and aided in the production of faults. Near some of these a slight metamorphism produced coked portions. This is graphitic coke and not anthracite as some assert. The seams are in many localities in a tilted condition and are worked at dips varying from 15 to 90°. In those portions where the dip is less steep the amount of moisture runs from 10 to 15 per cent. Most of the coals belong under the characterization of lignites. While far superior to the brown lignites of Dakota and Montana, these moist Washington coals do not stand transportation well and cannot be stored at all.

All Washington coals contain more ash and have a duller luster and lighter texture than Eastern coals. Having been deposited during Cretaceous-Tertiary times when the amount of carbon dioxide was greatly diminished, there is thus good reason for these different and interior characteristics. While many seams are of extreme thickness, there are few more than 6 feet that are not streaked and exceedingly dirty.

The containing walls of the coals of the seams are generally of shale and poor, but in a country plentiful in timber, this is not so serious a matter as elsewhere. Cleaning by the dry process will do much to benefit the quality of the coal. The coal is here and must be mined. The glacial deposits and forest coverings have done much to render prospecting difficult. We have, as yet, only a scant knowledge of the coal resources of the State.

The May Meeting of the Illuminating Engineering Society, Chicago Section.

The Chicago section of the Illuminating Engineering Society met at the Association Restaurant May 9. Mr. George C. Keech, Chairman of the Chicago section, presented a paper on "Industrial Plant Illumination." This paper gave the results of 8 sets of tests conducted in 5 different rooms. The tests were made with a Weber type of illuminometer, which was briefly described. These tests summarized were as follows:

A wood-working shop of 7,044 square feet area and ceilings 10 feet 10 inches high, was tested with three different kinds of illumination, the illumination being measured at 26 test stations on a plane 3 feet 4 inches above the floor. With mercury vapor lamps 9 feet 10 inches from the floor, the foot-candles per watt per square foot were 6.66. With clusters of Gem incandescent lamps under flat 15-inch porcelain reflectors hung 7 feet 10 inches from the floor the foot-candles per watt per square foot were 3.14. With 3-ampere 110-volt inclosed arc lamps hung 8 feet 5 inches from the floor the foot-candles per watt per square foot were 3.04. It was explained, however, in the discussion which followed the paper that the graphitized filament incandescent lamps, which were burned two in a series on 220 volts, had a very short life, which would seem to indicate that some of them were burning at considerably more than rated efficiency, due in part to unequal rating of the two lamps in a series.

In the linotype room of the Chicago *Tribune*, having 4,095 square feet and ceilings 14 feet 10 inches high, 3.5-ampere arc lamps hung 10 feet high gave an average of 2.65-foot candles per watt per square foot. Mercury vapor lamps in the same room hung 13 feet high gave 5.99 average foot candles per watt per square foot.

In a machine shop having 2,647 square feet area, with 11 feet 6-inch ceilings, mercury vapor lamps hung 8 feet 8 inches from the floor gave an average foot candles per watt per square foot of 6.12.

In a machine shop of similar size, having 2,744 square feet and 14 feet 8-inch ceilings, 5-ampere inclosed arc lamps gave 1.66-foot candles per watt per square foot.

In the drafting room of the North Works of the Illinois Steel Company, Chicago, mercury vapor lamps were arranged above each window to give the light as nearly the same direction as daylight as possible. This room had 3,914 square feet and gave 4.92-foot candles per watt per square foot.

During the reading of the paper, the author called attention to the fact that this was the first paper giving illuminating results presented before the Society in which the efficiency of illumination had been expressed in average foot-candles per watt per square foot, although Mr. Cravath, in the discussion at the March meeting had compared a number of the tests previously presented to the Society on this basis. The papers previously presented had not given results in any unit by which comparison of one installation with another could be made. The

average foot-candles divided by the watts per square foot gave a convenient unit of this kind, and thought it would be well to fix upon some short, less clumsy name for the unit than foot-candles per watt per square foot.

In the discussion Mr. O. C. Spurling objected to a light entirely without shadows. He also said that it was necessary to have an individual lamp at each piece of running machinery on account of the accident liability and the effect that the absence of such a lamp might have on accident claims. Mr. Albert Scheible thought the individual lamp unnecessary if an effect approaching daylight was produced. Mr. J. R. Cravath thought it a fallacy that shadows were necessary to clearly distinguish objects, because there are practically no shadows out-doors on a cloudy day, yet there is no difficulty in distinguishing objects clearly.

Mr. S. M. Bushnell called attention to the fact that in a factory regulation law recently presented at the Illinois Legislature one clause provided that no clear bulb incandescent lamps should be exposed in a factory. While this clause had been struck out, he believed it showed the general trend toward softer effects in lighting which would be easier on the eye. He commended the softness of the mercury vapor lamp.

Mr. N. R. Stansel gave the life results on 20 mercury vapor lamps running 24 hours per day in the Chicago post office. Fifteen of these tubes had run 7,000 hours to date. Five had broken or burned out. The lamps were hung only 8 feet 2 inches from the floor in this particular case, so that breakages amounted to more than burn-outs. These tubes apparently got brittle after many hours' use, so that if they were moved from one place to another after being in use some time, great care was necessary.

Mr. Cravath classified industrial plant lighting under 3 heads: 1. That by individual incandescent or gas lamps for each workman. 2. General lighting where the space is so flooded with light that individual lamps are not necessary. 3. A combination of the two methods. A system of lighting entirely by individual lamps was not entirely good, even when the individual lamps were properly shaded with efficient reflectors, because a light from one point only caused too much glisten and glare by reflection from tools and work. Such a system is cheap to operate, but not cheap when the results obtained from the workmen under such circumstances were figured. The tendency was more and more toward providing general lighting sufficient to obviate the necessity for individual lamps, but there are still many places where individual lamps will probably always be necessary.

Mr. Stansel said that in wood-working shops and steel plate shops general lighting without individual lamps was usually satisfactory. In furniture shops and erecting shops individual lamps were necessary, as lamps had to be put in places where no general system of illumination could reach. He condemned the use of a few isolated arc lamps where no other system of illumination was generally used, as such lamps were likely to be out much of the time on account of the lack of trimming and care.

Note on the Adiabatic Volume-Change on Mixing Two Gases.[1]

By Alfred J. Lotka, Laurel Hill, L. I.

In regard to certain chemical processes it is of interest to know what is the change in the total volume of two quantities of gases which are originally at different temperatures, and which are then mixed, without chemical action, so as to acquire one common temperature. It is, of course, a simple matter to work out the result as the need arises in each particular case, but a general investigation presents some points of interest.

Consider two gases, both at the same pressure, P mm. of mercury; let v_1 be the volume of the first; $t_1°$ C. its absolute temperature; and s_1 its specific heat at constant pressure and at the temperature $t_1°$. Also, let its density at o ° C. and 760 mm. be d_1, so that its actual density at $t_1°$ and P mm. will be:

$$\frac{P}{760} \cdot \frac{273\ d_1}{t_1}.$$

Similarly let v_2 be the volume of the second gas; t_2 its absolute temperature; s_2 its specific heat at constant pressure and at the temperature $t_2°$; d_2 its density at 0° C. and 760 mm.; hence its actual density at t_2 and P mm. will be:

$$\frac{P}{760} \cdot \frac{273\ d^2}{t^2}.$$

1. *Engineering and Mining Journal.*

Then, if the two gases are mixed in such manner that no heat either enters or leaves the system, and if T is the final temperature reached, we have for this adiabatic process the condition:

$$v_1 \frac{P}{760} \cdot \frac{273\ d_1}{t_1} \cdot s_1 (T - t_1) + v_2 \frac{P}{760} \cdot \frac{273\ d_2}{t_2} \cdot s_2 (T - t_2) = 0,$$

or:

$$d_1 s_1 \cdot v_1 \frac{T - t_1}{t_1} + d_2 s_2 \cdot v_2 \frac{T - t_2}{t_2} = 0. \tag{1}$$

The Volume Change.—Let us now consider the volume change. This will evidently be the same as if each gas had been separately brought to $T°$ at constant pressure, and the two had then been mixed; for in that case no further change in total volume would take place on mixing.

Now, if $\triangle v_1$ represents the change in volume v_1 corresponding to the change in temperature from t_1 to T_1 we have:

$$\triangle v_1 = v_1 \frac{T - t_1}{t_1}. \tag{2}$$

Similarly, the change in v_2 is given by:

$$\triangle v_2 = v_2 \frac{T - t.}{t_1}. \tag{3}$$

If $\triangle v$ is positive this means increase in v or expansion; a negative $\triangle v$ means contraction.

The change in the total volume $(v_1 + v_2)$, of the gases is given by:

$$\wedge (v_1 + v_2) = \triangle v_1 + \triangle v_2 = v_1 \frac{T - t_1}{t_1} + v_2 \frac{T - t_2}{t_2}. \tag{4}$$

From (1) we have:

$$v_2 \frac{T - t_2}{t_2} = - \frac{d_1 s_1}{d_2 s_2} \cdot v_1 \frac{T - t_1}{t_1}. \tag{5}$$

Substituting this in (4):

$$\triangle (v_1 + v_2) = v_1 \frac{T - t_1}{t_1} \left(1 - \frac{d_1 s_1}{d_2 s_2}\right). \tag{6}$$

We may solve (1) for T:

$$T = \frac{t_1 t_2 (d_1 s_1 v_1 + d_2 s_2 v_2)}{t_2 d_1 s_1 v_1 + t_1 d_2 s_2 v_2}, \tag{7}$$

and substitute this in (6)

$$\triangle (v_1 + v_2) = v_1 v_2 \frac{(t_1 - t_2)(d_1 s_1 - d_2 s_2)}{t_2 d_1 s_1 v_1 + t_1 d_2 s_2 v_2}. \tag{8}[1]$$

It is evident from (6), or more readily from (8), that if $t_1 > t_2$, *i. e.*, if v_1 is the hotter gas, $\triangle (v_1 + v_2)$ will be positive, zero, or negative, according as:

$$d_1 s_1 > d_2 s_2; \text{ or, } d_1 s_1 = d_2 s_2; \text{ or, } d_1 s_1 < d_2 s_2.$$

In other words, there will on the whole be expansion, no change, or contraction, according as the product ds for the hotter gas is greater than, equal to, or less than that for the colder gas. The same conclusion is, of course, reached on the supposition that $t_2 > t_1$.

A table, given herewith, shows in round numbers the value of the product ds for some of the principal gaseous elements and compounds:

The Value of ds for Some of the Principal Gaseous Elements and Compounds.

Substance.	ds.
Mercury, Hg (monatomic)	2.4
Argon, A (monatomic)	2.4
Helium, He (monatomic)	2.5
Hydrogen, H_2 (diatomic)	3.4
Nitrogen, N_2 (diatomic)	3.4
Oxygen, O_2 (diatomic)	3.5
Hydrochloric acid, HCl	3.4
Hydrobromic acid, HBr	3.3
Hydriodic acid, HI	3.5
Nitric oxide, NO	3.5
Carbon monoxide, CO	3.4

2. This result holds *strictly* only for gases which obey the laws of Boyle and Charles, and for which s is constant. It is independent of the units employed, so long as the temperatures are measured from absolute zero.

Substance.	ds.
Chlorine, Cl (diatomic)	4.4
Bromine, Br_2 (diatomic)	4.4
Iodine, I_2 (diatomic)	4.2
Iodine monochloride, ICl	4.1
Water vapor, H_2O	4.3
(s at 130-250° C.)	
Hydrogen sulphide, H_2S	4.1
Nitrous oxide, N_2O	4 9
Carbon dioxide, CO_2	4.3
(s at 0° C.)	
Carbon dioxide, CO_2	4.7
(s at 100° C.)	
Sulphur dioxide, SO_2	4.9
Ammonia, NH_3	4.3
Marsh gas CH_4	4.7
(Density of Hydrogen = 1.)	

It will be seen from the table, that the product ds, is approximately the same for a number of gases whose molecules are similarly constituted (Neumann's law); and that, as a rule, the gases with more complex molecules have also a greater value for ds, though this is not by any means invariably so. It must be borne in mind that the specific heat s is in general a function of the temperature, its variation with the latter becoming marked when the gas is approaching liquefaction, or is undergoing dissociation or association.

The case where $d_1s_1 = d_2s_2$ (*e.g.*, hydrogen and nitrogen), and where therefore (practically) no change in volume takes place on mixture, deserves brief consideration.

In this case, since the heat lost by the hot gas is equal to that gained by the cold gas, while at the same time the volume-pressure energy lost by the first is equal to that gained by the second, it follows that the fraction of the total heat change which appears or disappears in the form of volume pressure energy is the same for the two gases. Or, in the language of the kinetic theory of gases, the ratio,

$$\frac{\text{change in translational energy}}{\text{change in total energy}}$$

is the same for the molecules of either gas. This is in accordance with the fact that for a gas which obeys the laws of Boyle and Charles (as was assumed for the gas under consideration), the value of the produce ds fixes that of the ratio between the two specific heats. For such a gas the ratio of the two specific heats is given by

$$\frac{s_p}{s_v} = \frac{2\,ds}{2\,ds - 1.98}$$

Explosion Phenomena of Mixtures of Gas and Air.[1]

An issue of the "Mitteilungen über Forschungsarbeiten auf dem Gebiete des Ingenieurwesens" [Reports on Investigations in the Domain of Engineering], published by the Association of German Engineers a short time ago, contains a lengthy article by Dr. F. Häusser, of Kaiserslautern, on the above-named subject. Without reproducing the very voluminous tables accompanying the author's communication, it seems difficult to give a proper summary of his experiments; but in the following abstract translation an attempt has been made to indicate the manner in which his investigations were carried out, and the conclusions at which he has arrived.

The primary objects of the research were to review the accuracy of the formulæ given by Mallard and Le Chatelier for the specific heats of gases at high temperatures and at constant volumes, and to ascertain how these heats are affected by pressure. The experiments were performed on mixtures of air and coal gas, in spite of the variable nature of the latter, at different initial pressures; coal gas being selected as the combustible body because of the great practical importance of the phenomena attending its explosion, and because data are already available respecting the rapidity of its combustion in explosion engines, which data should form interesting matter for comparison with the explosion velocities observed during the investigation.

The explosion vessel employed by Dr. Häusser was a cast iron cylinder having a capacity of 335 cubic centimeters. A cylindrical shape was preferred to that of a sphere, because in the former a piston-like stirrer could be more effectually used to secure homogeneity in the gaseous mixtures. The handle of the stirrer projected from the end of the cylinder through a stuffing box; and it was found that the gland could be kept tight against the high final pressures if only the packing were renewed with sufficient frequency. The aperture for the igniting wire was in the side wall of the vessel, about two-thirds of its length from one end; the connection to the indicator being in the same transverse axis. The cock ordinarily used on the indicator could not be maintained air tight, and it was therefore replaced by a ball or hemispherical valve. The connections for the gas and air inlets, the removal of the final products, etc., were closed with needle valves, and gave no trouble. The indicator was a Rosenkranz instrument provided with a set of 6 springs, suitable for pressures up to 25 kilos. per square centimeter [1 kilo. per square centimeter is equal to about 0.968 atmosphere]. The paper drum was revolved by a single phase electric motor supplied with current from the local generating station; it therefore synchronized with the dynamos within very narrow limits, revolving the paper at 1,400 turns per minute. The pressure gauge attached to the cylinder was calibrated by the Reichsanstalt.

Tests were made of the amount of heat lost during the explosion by absorption into the walls of the cylinder. For this purpose, the short igniting coil was removed, and a long platinum wire, of known resistance, was introduced into the cylinder through the coil aperture, bent twice upon itself so as to reach almost to the two ends of the vessel, and brought out again through the indicator connection. The wall of the cylinder was drilled almost through at one spot; a thermometer being placed in the hole with its bulb in a bath of mercury, and a second inserted into the interior at the opposite end. An electric current of known wattage was then passed through the wire to render it incandescent; and as soon as the second thermometer remained constant its reading and that of the first thermometer were noted. The coefficient of heat conductivity of the walls of the cylinder (ε)—*i. e.*, the amount of heat in small calories passing to the metal per second per 1° C. of difference in temperature between the interior of the vessel and the walls—was obtained by the following equation:

$$\varepsilon\,(t_2 - t_1) = 0.239\,J^2W,$$

where t_2 is the temperature shown by the thermometer in the interior of the cylinder, t_1 the temperature shown by the thermometer in the mercury bath, J the amperage of the current, and W the resistance of the wire in ohms. Two determinations of ε under very different conditions gave 0.533 and 0.526 small calorie respectively. Preliminary experiments having shown that the walls of the cylinder gradually suffered corrosion from the explosions, and so altered in heat conducting power, the cylinder was lined with white enamel before the main investigation was begun. The values for ε just given relate to the cylinder after being so enamelled.

As it was not possible to work at higher final pressures than 25 to 26 kilos, per square centimeter, the highest degree of compression to which the original gaseous mixtures could be brought was 5.11 kilos, absolute, as measured before the valve leading to the indicator was opened. This opening caused a small reduction in the compression, which was, of course, allowed for. Hence, five series of experiments were performed, in which the original compression was 1.01, 1.90, 2.80, 3.55 and 4.40 kilos. per square centimeter respectively. In each series, the proportion of coal gas in the gaseous mixture varied from about 7 to about 16 per cent. by volume.

The coal gas contained on an average 3.6 per cent. of carbon dioxide, 4.7 per cent. of heavy hydrocarbons, 0.7 per cent. of oxygen, 8.3 per cent. of carbon monoxide, 50.2 per cent of hydrogen, 29.6 per cent. of methane, and 2.9 per cent. of nitrogen by volume. Its specific gravity at 0° C, and 760 mm. was 0.5641, and the specific gravity of the heavy hydrocarbons in it was 1.975. Its gross calorific value, as determined in a Junker's calorimeter, was 668 B.T.U. per cubic foot at 0° C. and 760 mm., or, allowing for contraction, 618 at constant pressure. Its net calorific value at constant volume was hence calculated to be 600 B.T.U. per cubic foot at 0° C. and 760 mm. By calculation from the average chemical composition of the gas, its calorific value appeared to be 576 B. T. U.; the difference of 4 2 per cent. being due to the errors involved in deducing calorific value from chemical analysis in which all the "heavy hydrocarbons" are estimated together. Determinations of the proportion of carbon dioxide in the explosion products showed that each volume of the total heavy hydrocarbons in the original coal gas required 3.3 volumes of oxygen for their complete combustion, yielding 2.2 volumes of carbon dioxide and 3 volumes of water vapor. The compressed air used in the experiments had the composition of normal air. An amount of 0.2 per cent. by volume of carbon dioxide in it (derived from traces of this gas clinging to the storage cylinder from a previous charge) could be fairly ignored. Estimations of the proportion of nitrogen in the gaseous mixtures fired and in the several

[1] *Journal of Gas Lighting.*

combustion products, gave concordant results—indicating that the combustion of the gas in mixtures containing up to 14 or 15 per cent. by volume of it was perfect within the limits of experimental exactitude.

Some Results Obtained.—The five series of explosions at the five different initial pressures already mentioned showed that gaseous mixtures containing 15 to 16 per cent. by volume of coal gas burnt about ten times as rapidly as mixtures containing only 8 or 9 per cent. The effect of the initial pressure upon the velocity of the explosion appeared to be small; but perhaps an increase in the compression slightly hastened the explosion of the richer gas mixtures, and slightly slowed the explosion of the poorer ones. Defining the duration of the explosion as the interval in seconds between the moment of ignition and the moment when the indicator showed the maximum pressure, some idea of the author's figures may be conveyed by those given below.

Initial Compression.	Percentage of Coal Gas in Mixture.		
	8-9	11-12	15-16
1.01	0.236	0.074	0.040
1.90	0.329	0.081	0.025
2.80	0.421	0.073	0.028
3.55	0.353	0.087	0.023
4.40	0.304	0.090	....

These results do not agree well with others that have already been placed on record. For example, some 5 years ago, Meyer carried out experiments in an engine with a coal gas very similar in composition and calorific power to the material used by Dr. Häusser. Meyer's mixtures contained from 10.1 to 11.8 per cent. by volume of gas; and his explosion velocities ranged from 0.025 to 0.035 second, whereas conformity with Dr. Häusser's results would demand velocities of from 0.085 to 0.125 second. Of course, conditions in an engine cylinder are not strictly analogous to those obtaining in an experimental explosion vessel. The engine cylinder is warm, heats the charge, and hastens the explosion. On the other hand, the charge in an engine is contaminated with the combustion products, which should retard combustion. On the whole, it would seem the moment of maximum pressure shown by an indicator on a gas engine cylinder does not signify the end of the combustion, which must continue after that moment as the piston travels onwards. This should be true even if the gaseous mixture supplied to the engine is homogeneous. A more rapid combustion is to be obtained by the employment of richer mixtures, and by thorough commingling of the gas and air.

The mean specific heats at constant volume of the combustion products were first calculated from the thermo-chemical data collected during the research on the assumption that no dissociation occurred. Five different calculations were carried out for gaseous mixtures containing from 11 to 15 per cent. by volume respectively of coal gas; three different initial pressures being employed. The averaged results were: For an initial pressure of 1.90 kilos. per square centimeter absolute, 0.420; for one of 2.80 kilos. absolute, 0.3684; for one of 3.55 kilos. absolute, 0.3536. Two similar calculations made for an initial pressure of 4.40 kilos. gave a specific heat of 0.3415. Application of Mallard and Le Chatelier's formulæ to the five different combustion products obtained at an initial pressue of 3.55 kilos. per square centimeter absolute led to an average mean specific heat at constant volume of 0.258. It will be seen that the author's experimental results are much lower than those given by the Mallard and Le Chatelier formulæ, but the former tend to approach the latter as the initial pressure increases. The differences between the results also diminish as the temperatures attained during explosion rise. The Mallard and Le Chatelier formulæ were obtained from experiments at temperatures exceeding 1,900° C.—a point which was seldom reached by Dr. Häusser. It is also quite probable that the correction employed by him for the loss of heat during explosion, deduced in the manner previously described, was too small; for the radiating power of a mass of gas completely filling the cylinder at a medium temperature of from 500° to 900° C., is, no doubt, greater than that of a thin platinum wire at a bright red heat.

The next point studied by Dr. Häusser was the influence exerted upon the explosions of any endothermic reactions taking place simultaneously. It was found that the oxidation of the nitrogen was too small in extent to exert any appreciable effect upon the heat liberated, or upon the mean specific heat of the combustion products. Only when the initial pressure reached 3.55 kilos. per square centimeter did the oxidation of nitrogen become as noticeable in its effects as the loss of heat by passage into the substance of the experimental cylinder. Similarly, the decomposition of the carbon dioxide into carbon monoxide was negligible in a gaseous mixture containing some 15 per cent. by volume of coal gas, and would be of no importance even at temperatures somewhat exceeding those observed by the author. On the contrary, the effect produced by the dissociation of water vapor was found to be serious at temperatures exceeding 2,000° C., even when such poor mixtures were exploded as it is customary to use in internal combustion engines.

As the dissociation constant of water vapor has not yet been directly measured, the author calculated it from Bose's value for the electromotive force of a gas cell at 25° C.—*i. e.*, 1.139 volts—using the method suggested some time ago by Preuner and the formula given by Van 't Hoff for connecting the constant with temperature. In this manner, Dr. Häusser obtained the following formula for the dissociation of water vapor:

$$\log K + \frac{24.678}{T} - 3.3 \log T + 0.000654\,T = 0.749$$

$$\text{or} \qquad K = \frac{p_h^2\,(p_o + 0.5\,p_h)}{(p_o - p_h)^2}.$$

where p_o is the partial pressure of the oxygen, after allowing for the formation of nitric oxide; p_w, the partial pressure of the water vapor in the combustion products if no dissociation occurred; and p_h, the partial pressure of the hydrogen after dissociation. Hence it can be shown that, starting with an initial compression of 3.55 kilos. per square centimeter absolute, the formation of free hydrogen may absorb 7.8 per cent. of the total heat liberated at a temperature of 2,030° C., and 13.1 per cent. of the total at 2,140° C. With allowance for this amount of dissociation, the mean specific heats of the combustion products at constant volume up to the two temperatures just mentioned are represented to be 0.322 and 0.306 respectively; Mallard and Le Chatelier's formula giving 0.267 and 0.279.

The generals conclusions drawn by Dr. Häusser from his investigations are summed up by him as follows:

(1) The duration of the explosion of a mixture of coal gas and air may be said to be independent of the pressure at which it originally exists.

(2) From a comparison of the periods of time occupied by the experimental explosions with those which proceed in an engine cylinder, it would appear that combustion in the cylinder is not complete at the moment when the indicator shows the maximum pressure, even if the gaseous mixture is thoroughly homogeneous; nor, if the proportion of gas present exceeds a certain amount, is it complete at the moment when the piston begins its forward stroke. In this respect the use of more rapidly burning mixtures would be preferable.

(3) In the explosive combustion of mixtures of coal gas and air, the dissociation of water vapor produces a distinct effect upon the quantity of heat liberated at all temperatures above 1,750° C., but the decomposition of carbon dioxide and the formation of nitric oxide are negligible factors.

(4) The increase in pressure accompanying explosion—*i. e.*, the ratio of the initial to the final pressure—is not always the same, but increases with increasing initial pressure.

(5) The experiments demonstrate the accuracy of the Mallard and Le Chatelier formulæ for the specific heats of the combustion products obtained from mixtures of coal gas and air, provided the initial pressure is some 3.5 kilogrammes per square centimeter or upwards, and the temperature attained is above 1,800° C. When the temperature or the pressure is lower, the final pressures calculated from the formulæ are higher than those which actually arise.

(6) An application of the simple gas laws (Boyle and Gay-Lussac) to the explosive combustion of mixtures of coal gas and air, with the object of calculating the temperature of explosion from the rise in pressure, shows the specific heats of the combustion products to be a function of the pressure, decreasing as the pressure increases.

Rapid Method for Estimating Acetone.

Mr. Albert P. Sy, of the Buffalo (N. Y.) University, communicated the following rapid method for the estimation of acetone to the May number of the "Journal" of the American Chemical Society:

In order to be able to estimate rapidly the acetone content of the distillate from crude wood naphtha during rectification, the author has adapted the well-known Messinger method, so that the burette readings give the number of grams of acetone in 100 cc. (sometimes expressed as per cent.) directly.

Procedure.—Put 10 c.c. of 2N sodium hydroxide solution into a wide mouth glass stoppered bottle, then add exactly 1 c.c. of the alcohol to be examined, shaking; next add 50 cc. of the standard iodine solution

while shaking; after 3 minutes acidify with dilute sulphuric acid (use about $2NH_2SO_4$); now add starch indicator and titrate back with standard thiosulphate solution. The number of cubic centimeters of iodine solution used by the acetone gives the number of grams of the latter in 100 c.c.

For the back titration the writer uses a burette graduated from 0 to 50 c.c. in $\frac{1}{10}$, beginning at the bottom; after titration, the burette reading gives grams of acetone in 100 c.c. directly, avoiding a subtraction of the reading from 50.

In accordance with the equation:

$$(CH_3)_2CO + 3I_2 + 4KOH = CHI_3 + K(C_2H_3O_2) + 3KI + 3H_2O.$$

0.01g. of acetone requires 0.1312 g. of iodine. A standard iodine solution is, accordingly, prepared to contain 131.2 g. of iodine in one liter; the standard thiosulphate solution is prepared of equivalent strength.

This method is intended for spirits in which the acetone is high, but does not exceed 50 per cent. In cases where the acetone does not run over 25 per cent. a 25 c.c. burette, graduated from the bottom, should be used for the thiosulphate solution, and, of course, only 25 c.c. of the iodine solution are used. For solution containing 5 per cent. or less of acetone, 10 c.c. of the sample may be taken, using the 50 c.c. burette; readings in this case are 0.1 per cent. for each c.c. iodine used.

Power Plant Diaries.

A contemporary remarks that station log books, or records in some form, of fuel and water consumption, hours of labor and times of putting machines in and out of service are kept in all well operated power plants, but the usefulness of an engineer's diary is less generally appreciated. Many engineers may not favor such extra clerical work, but where the habit of recording important happenings day by day is not a serious burden, the operating company is likely to find it of value.

In a recent instance a company operating a suburban power plant purchased a new gas engine, which did not give satisfaction. For over 6 months the manufacturer endeavored to correct the faults, supplying new parts, making valve adjustments and altering details of the bearings and other mechanism until the outfit had been practically rebuilt. During the entire period the manufacturer kept from 2 to 6 men at work on the machine several days in each week. The executive office of the operating company finally concluded that the machine was a failure, and to secure definite data supporting its contention asked the chief engineer to submit to the general manager the next morning, for use at a directors' meeting, a general statement of the machine's history from the time of installation. The engineer referred to a station diary which he always kept and dictated a complete account of each day upon which work was done in connection with the troublesome unit. On the basis of these detailed statements the company decided to substitute another engine for the first, and the engineer had the satisfaction of fulfilling a difficult request with very little trouble.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

THE authorities of Manitowoc, Wis., have refused to purchase the properties of the Manitowoc Gas and Light Company, despite the fact that the Council Committee appointed to investigate the matter reported that the plant was first-class in every particular and that the business being done by the Company is as was represented. The operating franchise provided that before the original owners could sell the properties to others the first call should be given to the city, hence the offer to the city. The upset price was $60,000. The plant will now be sold to New York capitalists at the figure at which it was offered for public auction.

MAY 19th was semi-annual quarterly dividend day with the owners of stock in the Grand Rapids (Mich.) Gas Company, on which date the regular stockholders received a quarterly dividend of 2½ per cent. in cash, and the employees received a dividend of 10 per cent. on the respective amounts of their salaries for the half year, ended April 30. The amount paid over on latter account was not far from $8,000.

A MEETING of the stockholders in the Toledo (O.) Railway and Light Company is called for June 10th, in Toledo. The purposes of the call are to consider the proposition to increase the capital to $15,000,000 from $12,000,000, and to ratify the purchase of the Toledo Gas and Heating Company.

THE Western Gas Construction Company, of Fort Wayne, Ind., has purchased the small residence at the corner of Reed and Buchanan streets, which plot is opposite their present offices The structure will be remodelled to suit it for the needs of the Company's draughting force.

MR. FRANK W. CRAIN has been appointed Assistant Superintendent of the Eclipse Gas Stove Works, Rockfort, Ills.

MR. W. W. BRUNT has resigned the post of City Clerk of Monmouth, Ills., to accept a responsible place in the service of the Monmouth Gas and Electric Company.

AT the annual meeting of the Erie (Pa.) Gas Company the officers elected were: President, E. D. Carter; Vice-President, Wm. McDonald; Secretary and Treasurer, Paul Mueller.

A VERY interesting paper on "Gas Power at the Central Station of the Duquesne Lighting Company" was recently read by Mr. Norman B. McPherson at a session of the Pittsburgh (Pa.) branch of the American Institute of Electrical Engineers in the Lecture Hall of the Pittsburgh Carnegie Technical Schools.

MR. DANIEL N. TIERNAN, prominent in the clerical force of the Municipal Gas Company, Albany, N. Y., died at his home in Albany the morning of May 15th. Deceased was in his 55th year, having been born in Albany October 27, 1852. He became identified with the Municipal Company in 1892.

HERE is a "grievance" under which certain men employed by the Portland (Me.) stevedoring firm of Trefethen & Dugan, while unloading coal from a barge moored alongside the wharf of the Portland Gas Light Company, struck. They struckbecause they "disliked" a certain man employed by the stevedores on another job in another part of the city!

JNO. J. HANNAN, a trusted bookkeeper in the employment of the Baltimore branch of the Welsbach Company, recently confessed to having embezzled something over $1,000. The Company consented to a suspension of sentence.

VISITING gas men are invited by the Western Gas Construction Company to inspect the 6-inch Stoever pipe threading machine recently installed in its Fort Wayne factories.

THE contention between the owners of the Citizens Gas and Fuel Company, of Terre Haute, Ind., and Mr. Martin N. Diall, the General Manager, over the tenure of his office, has been settled. Mr. Diall retains his position until July 23, on which date he will be succeeded by Mr. E. A. Wakeman, of Glens Falls, N. Y.

WE are indebted to Mr. R. A. Lewis for the following respecting a lively time. The story is this, and it relates to a happening in Wilkes-Barre, Pa., last May: "The electric light employees of the Wyoming Valley Gas and Electric Company were given a dinner recently at the Central Hotel by the gas employees of the same Company. Nearly all the Company's employees from the 20 towns in which the Company does business were present. The dining room was beautifully decorated with bunting and handsomely illuminated for the occasion. The *menu* was all that could be desired and reflected credit upon mine host Findley, who 'knows how to run a hotel.' Attorney R. R. Van Horn acted as toastmaster and filled the position in an able manner. The following responded to toasts: W. C. Anderson, General Manager, 'Tie Wires and Pipe Straps;' A. J. Llewellyn, Assistant Manager, 'The Result of Electric Trouble on a Married Man;' D. T. Scott, Superintendent, Kingston, 'How to Enter a Consumer's Home to Read a Meter when the Husband is Absent;' J. K. Graham, Superintendent, Nanticoke, 'How to Collect a Gas Bill from the Lady after a Family Tilt;' C. Robins, 'Short Stops;' M. Richards, 'How to Meet Her;' R. A. McGregor, 'Phonographic Expressions Rendered with a Loose Connection or Storms—Brain or Electric;' Joe. Thomas, 'Groans of an Electric Meter;' George Harrison, 'The Number of 6,600;' E. Brenner, 'Mysteries of a Cross Arm;' D. Davis, 'The Result of Connecting a Primary and Secondary Together;' L. Evans, 'Hand Lines and Clothes Lines;' J. Hagel, 'Results of Short Circuit between Porcelain and Glass;' J. Hendershot, Chief Engineer, 'Electric Chickens;' S. Lorah,

Superintendent Gas, 'How to Maintain Pressure;' R. Clark, 'High and Low Pressure Tapping Machines.' A quartet of the gas men rendered an original song entitled 'Gas,' which brought forth considerable applause. Every individual of the many present had his say and it was a great loss to the Company that some method could not have been adopted to collect the effusions of the speechmakers, as enough gas was wasted to fill many a main."

THE Selectmen of Montague, Mass., have authorized the Greenfield (Mass.) Gas Light Company to extend its main system to the outlying borough of Turner's Falls. The main conditions are that the streets are to be completely piped within 2 years, and at no time is the gas rate in Montague to exceed that charged in Turner's Falls.

MESSRS. DAWSON & HOLBROOK, a local firm of architects, have been authorized to plan for notable additions to the building, at Front and Gay streets, Columbus, O., occupied by the Federal Gas Company as its administrative headquarters. When completed, the building will be one of the most attractive of the structures in that city devoted to business purposes.

THE Waynesboro (Pa.) Gas Company has opened its handsome, new appliance showroom. The task was put on Mr. Edward Warren, and the results of his study and application to the work in hand well merit the compliments that have been given to his Company and to himself.

MR. CHARLES E. ROWE and associates are arranging for the construction and operation of a gas plant in Goldfield, Nev., under the franchise granted to him last November. A modern plant will be constructed, and Mr. Rowe figures it out that it will take $150,000 to construct the system complete.

ON the 13th inst. the Union Gas Engine Company, of San Francisco, voting to determine whether or not a bonded indebtedness of $200,000 shall be authorized, voted yes.

THE "Staten Islander," of May 4th, contains a very interesting *resumé* of the history of gas making and gas selling in and on Staten Island, N. Y. The supply was commenced in April, 1857, and the description of the works, and the business done therefrom in those days, makes a queer contrast with that now being carried on under that hustling gas maker and gas seller, Mr. Thomas O. Horton.

MR. C. W. KOINER, who, since 1905, has served the National Light and Improvement Company, of St. Louis, Mo., as Secretary, Treasurer and Engineer, which corporation owns and operates several gas, electric light and railway plants in Kansas and Texas, has been appointed General Superintendent and Engineer to the Los Angeles (Cal.) Gas and Electric Company.

SOME of the Clevelandites are urging the appointment of many more "expert" meter inspectors for public account in Cleveland. Mr. W. J. Springborn, Director of Public Service in that city, however, does not seem particularly well impressed with the good policy of such proceeding, for when recently appealed to by a reporter to give his views on the good policy of making such appointments, said: "It would offer too great opportunity for the building up of a gigantic political machine. The idea comes from Cincinnati. It may be adopted there, but not in Cleveland. There are, perhaps, 130,000 gas meters in Cleveland, possibly more. You can see the possibilities. Suppose, just prior to the election, the city should put on 1,000 or more inspectors to go over the field, the Gas Companies to pay the bill. It would be as unjust as it would be dangerous. The present system of inspection comes as near being right as anything I have seen."

THE Board of Governors of the Columbus (O.) Stock Exchange has agreed to list the securities issued by the Childs-Hulswitt Company, of Chattanooga, Tenn. These include $40,000 of 6 per cent preferred stock, $750,000 of common stock, and $1,500,000 of 5 per cent. bonds.

To go back to Cleveland and gas meter inspection, it is noteworthy to remark the opinion of the City Chemist, of Cleveland, thereon. He (Mr. Pate) said: "Scores of meters have been tested in the Chemist's office in the last two years. The great majority of the tests show that the meters are either correct or slow. Not 1 meter tested out of 100 reads fast. In fact, inspections generally show that meters are slow."

MR. C. FULLER has been appointed Superintendent of the Carlisle (Pa.) Gas and Water Company, vice Mr. Charles Ramsey, resigned.

MR. J. N. STICKELL has resigned as Superintendent of the Waynesbore (Pa.) Gas Company. His successor is Mr. Edward Warren.

THE long, honorable and useful life of Mr. John Turner was ended by death, the morning of the 22d ult., who then passed away at his home in Charlestown, of which district he had been a resident since 1852. He was in his 81st year, having been born in North Salem, Me., January 23d, 1827. He served on the Board of Directors of the Charlestown (Mass.) Gas and Electric Company for several years, and was an intimate friend of the late Mr. George B. Neal.

THE following was forwarded by a Baltimore correspondent under date of the 26th ult.: "In an opinion which was handed down by Judge Stockbridge, Part 2, Baltimore City Court, the Consolidated Gas Company came out victorious in its appeal from the easement assessment of the Appeal Tax Court in connection with its mains and pipes for the year 1906. Judge Stockbridge decided that the easement value must be abated from $6,000,000 to $3,350,286. It was the third trial of the case in the local courts, and the first decision against the city in these courts. Twice the Court of Appeals reversed the decision of the Baltimore courts and declared in favor of the Gas Company. Judge Stockbridge arrived at the value of the easements by taking the average of the annual charge made by the city to the Chesapeake and Potomac Telephone Company and the Baltimore Refrigerating and Heating Company, which he multiplied by the number of miles of the mains of the Gas Company, capitalizing the result at an interest of 4½ per cent. It was set forth in the opinion that the valuation of the easement is not such as to include all the value of the franchises enjoyed by the Company, but the method cannot be said to be at issue as to conforming to any standard or rule established by law, for there is none such. The appeal was not against the original assessment, it is stated, but only against the additional assessment of $6,000,000. It was objected in the case that the Court could make no valuation, because there is no standard of measurement of value, and that any amount which was named would be arbitrary. In answer to this Judge Stockbridge said that it is true that there is no method for the determination of value prescribed by any statute. Furthermore, it is admitted that in one sense any valuation whatever placed upon this right of the Company is an arbitrary ascertainment, but it is no more true than it is of every assessment of property for purposes of taxation that the value assigned to it is arbitrary, even when fixed as the result of the exercise of the best skill and judgment which can be brought to bear by the individual or tribunal which passes such valuation upon the property. It is possible, however, by comparison or analogy to reach an approximation of value which is neither unjust to the individual or corporation enjoying the right of easement, nor to the municipality from which such right is derived. Four analogies of this character were suggested to the Court. They were the charge made by the city for a vault or area constructed under some portion of the abutting highway and designed to be used in connection with the adjacent property; the charge made to individual holders of a right from the city to lay a sewer drain or a pipe to connect a given piece of property with a public sewer; the charge or rental reserved by ordinance of the Mayor and City Council for the right to place in the highways of the city pipes or conduits designed to convey steam or hot or cold air from a central station to the consumers in other sections of the city, and the similar charge or rental imposed upon the Chesapeake and Potomac Telephone Company for the right to lay its conduits for wires in the streets of the city, connecting its subscribers with a central exchange. The opinion notes striking points of difference between the comparison of charges made for the Chesapeake and Potomac Telephone conduits and the Refrigerating and Heating conduits. Taking into consideration the character of the right enjoyed, as compared with other similar rights, it is said, and mindful of the fact that the rights of the Gas Company consist of three elements—the construction, the easement and a franchise—it has seemed just to the Court to capitalize the valuation of an annual charge determined in the manner indicated on the basis of 4½ per cent., amounting to $3,238,400. The additional $111,886 is for the new and conceded additional construction, and the $3,238,400 is for the easement enjoyed by the Company for its 480 miles of mains."

MR. C. S. STEPHENSON, of Ansonia, O., has been granted a franchise for the construction and operation of a gas works in Lawton, Oklahoma.

THE New Orleans (La.) Gas Light Company has ordered a reduction of 5 cents in the selling rate. This makes the net price $1.15 per 1,000.

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The Market for Gas Securities.

The "reason" for the last bear movement in Consolidated was a concerted attack on the right of the Company to do business at all in the city. The "attacks" were led, respectively, by the Attorney-General of the State and by the Corporation Counsel of the city, and the same looked as if unity controlled the action. The bare facts as they stand are that this great property seems to be the football of those who misrepresent us in official position, and this kicking is and has been more positive since the allotments made to "expense account" each year the Legislature was in session have been blotted off the Company's fiscal "memos." Consolidated opened to-day (Friday) at 119½ bid. During the week the stock "broke" 112.

The outside market was dull and drooping, save in respect of Washington gas. Certainly Peoples, of Chicago, looks very cheap at under 90.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.

JUNE 3.

☞ All communications will receive particular attention.

☞ The following quotations are based on the par value of $100 per share.

N. Y City Companies	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	119½	120
Central Union Gas Co.—				
1st 5's, due 1972, J. & J.	3,090,000	1,000	101	104
Equitable Gas Light Co.—				
Con. 5's, due 1932, M. & S.	1,000,000	1,000	..	105
Mutual	3,500,000	100	190	225
New Amsterdam Gas Co.—				
1st Con. 5's, due 1948, J. & J.	11,000,000	1,000	98	100
New York & Richmond Gas Co. (Staten Island)	1,500,000	100	37	43
1st Mtg. Gold 5ds. 5 p.ct.	1,000,000	..	98	104
Northern Union—				
1st 5's, due 1927, J. & J.	1,250,000	1,000	101	103
New York and East River—				
1st 5's, due 1944, J. & J.	3,500,000	1,000	108	111
Con. 5's, due 1945, J. & J.	1,500,000	..	104	110
Standard	5,000,000	100	140	160
Preferred	5,000,000	100	155	175
1st Mtg. 5's, due 1930, M. & N	1,500,000	1,000	104	108
The Brooklyn Union	15,000,000	1,000	110	115
1st Con. 5's, due 1948, M. & N	15,000,000		107	..
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Bay State	50,000,000	50	¼	⅜
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	..	65
" 1st Mtg. 5's	509,000	1,000	95	100
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	9	10
" " Bonds, 5's	5,250,000	1,000	75	80
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	106¾
Cincinnati Gas and Electric Co.	29,500,000	100	98	98½
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	90	..
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	87	88
Preferred	3,026,500	100	107½	108
Consumers, Toronto	2,000,000	50	200	204
Consolidated, Baltimore	11,000,000	100	.	90
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
Con. Mtg. 5's	880,000	1,000	92	95
Bonds	75,000	..	..	100
Detroit City Gas Co.	5,000,000	50	..	50
" Prior Lien 5's	4,618,000	1,000	..	98
Detroit Gas Co., 5's	381,000	1,000	75	80
" Inc. 5's	16,000	100	98½	100
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	39	40
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,325,500	1,000	104½	105
Hartford	750,000	25	190	200
Hudson County Gas Co., of New Jersey	10,500,000	..	110	112
Bonds, 5's	10,500,000	..	107½	108½
Indianapolis	2,000,000	..	60	70
" Bonds, 5's	2,650,000	..	104½	105
Jackson Gas Co.	250,000	50	82	..
" 1st Mtg. 5's	290,000	1,000	97	100
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	86
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	..	05
Preferred	2,500,000	100	95	110
Bonds	10,000,000	1,000	104	104½
Lafayette Gas Co., Ind.	1,000,000	100	..	60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	143	145
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	106	108¾
" 6 per cent. scrip, due 1910	100,000	25	85	87
Massachusetts Gas Companies of Boston	25,000,000	100	59	..
Preferred	25,000,000	100	83	..
Montreal, Canada	2,000,000	100	218	218¾
Nashville Gas Lt. Co.	1,000,000	100	110	..
Newark, N. J., Con. Gas Co.	6,000,000	..	56	58
Bonds, 6's	6,000,000	..	137	138
New Haven	2,000,000	25	200	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	89¼	90
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
" 2d "	2,500,000	1,000	104	..
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	104½	105½
San Francisco, Cal.	15,800,000	100	..	..
St. Joseph Gas Co. 1st Mtg. 5's	751,000	1,000	92	..
St. Paul Gas Light Co	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	118	116
Extension, 6's	600,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	96¼	..
Syracuse, N. Y.	1,975,000	100	50	55
Bonds	2,047 000	1,000	102	..
Washington, D. C	3,600,000	20	300	305
First mortgage 6's	600,000	..	..	..
Western, Milwaukee	4,000,000	..	..	..
Wilmington, Del.	600.000	50	220	..

Advertisers' Index.

GAS ENGINEERS.

	Page
A. E. Boardman, New York City	949
Baxter & Young, Detroit, Mich	949
B. E. Chollar, St. Louis, Mo	952
Cruse-Kemper Co., Philadelphia, Pa	948
Davis & Farnum Mfg. Co., Waltham, Mass	960
Economical Gas Apparatus Construc'n Co., Toronto, Ont	959
Frank D. Moses, Trenton, N. J	962
Frederic Egner, Norfolk, Va	964
H. M. Byllesby & Co., Chicago, Ills	947
Humphreys & Glasgow, New York City	960
Isbell-Porter Co., Newark, N J	948
Kerr Murray Mfg. Co., Fort Wayne, Ind	961
Practical Gas Construction Co., North Chicago, Ills	960
The Gas Machinery Co., Cleveland, O	944
The Jeffrey Manufacturing Co., Columbus, O	958
United Gas Improvement Co., Philadelphia, Pa	960
Western Gas Construction Co., Fort Wayne, Ind	924

GAS WORKS APPARATUS AND CONSTRUCTION.

A. E. Boardman, New York City	949
Bartlett, Hayward & Co., Baltimore, Md	961
Baxter & Young, Detroit, Mich	959
Connelly Iron Sponge & Governor Co., New York City	967
Continental Iron Works, Brooklyn, N. Y	962
Cruse-Kemper Co., Philadelphia, Pa	948
Davis & Farnum Mfg. Co., Waltham, Mass	960
Deily & Fowler, Philadelphia, Pa	964
Economical Gas Apparatus Construc'n Co., Toronto, Ont	959
Frank D. Moses, Trenton, N. J	962
Humphreys & Glasgow, New York City	960
Isbell-Porter Company, New York City	948
Kerr Murray Mfg. Co., Fort Wayne, Ind	961
Lloyd Construction Co., Detroit, Mich	950
Logan Iron Works, Brooklyn, N. Y	964
Quintard Iron Works, New York City	960
R. D. Wood & Co., Philadelphia, Pa	962
Riter-Conley Mfg. Co., Pittsburgh, Pa	963
Stacey Mfg. Co., Cincinnati, O	963
The Gas Machinery Co., Cleveland, O	944
The Jeffrey Manufacturing Co., Columbus, O	958
United Gas Improvement Co., Philadelphia, Pa	955
Western Gas Construction Co., Fort Wayne, Ind	924

PROCESSES.

Bartlett, Hayward & Co., Baltimore, Md	961
B. E. Chollar, St. Louis, Mo	952
Economical Gas Apparatus Construc'n Co, Toronto, Ont	959
Humphreys & Glasgow, New York City	960
Semet-Solvay Co., Syracuse, N. Y	958
The Gas Machinery Co., Cleveland, O	944
United Gas Improvement Co., Philadelphia, Pa	955
Western Gas Construction Co., Fort Wayne, Ind	924

SCRUBBERS AND CONDENSERS.

Continental Iron Works, Brooklyn, N. Y	962
Cruse-Kemper Co., Philadelphia, Pa	948
Davis & Farnum Mfg. Co., Waltham, Mass	960
Economical Gas Apparatus Construc'n Co., Toronto, Ont	959
Isbell-Porter Co., Newark, N. J	948
Kerr Murray Mfg. Co., Fort Wayne, Ind	961
Logan Iron Works, Brooklyn, N. Y	964
R. D. Wood & Co., Philadelphia, Pa	962
Riter-Conley Mfg. Co., Pittsburgh, Pa	963
Stacey Mfg. Co., Cincinnati, O	963
The Gas Machinery Co., Cleveland, O	944
Western Gas Construction Co., Fort Wayne, Ind	924

PRODUCER POWER PLANTS.

Economical Gas Apparatus Construc'n Co., Toronto, Ont	959
R. D. Wood & Co., Philadelphia, Pa	962

TAR AND CARBONIC ACID EXTRACTOR.

Economical Gas Apparatus Construc'n Co., Toronto, Ont	159
Isbell-Porter Co., Newark, N. J	948
Kerr Murray Mfg. Co., Fort Wayne, Ind	961
Stacey Mfg. Co., Cincinnati, O	963
The Gas Machinery Co., Cleveland, O	944
Western Gas Construction Co., Fort Wayne, Ind	924

AMMONIA CONCENTRATORS.

Michigan Ammonia Works, Detroit, Mich	942
The Gas Machinery Co., Cleveland, O	944
Western Gas Construction Co., Fort Wayne, Ind	924

GAS METERS.

American Meter Co., New York and Philadelphia	967
Detroit Meter Company, Detroit, Mich	942
D. McDonald & Co., Albany, N. Y	965
Helme & McIlhenny, Philadelphia, Pa	967
John J. Griffin & Co., Philadelphia, Pa	968
Keystone Meter Co., Royersford, Pa	966
Maryland Meter and Mfg. Co., Baltimore, Md	966
Metric Metal Co., Erie, Pa	967
Nathaniel Tufts Meter Co., Boston, Mass	966
New York Improved Meter Co., New York City	968
Pittsburg Meter Co., East Pittsburg, Pa	965
Rotary Meter Co., New York City	943
United States Meter Co., Brooklyn, N. Y	962

PREPAYMENT METERS.

American Meter Co., New York and Philadelphia	967
D. McDonald & Co., Albany, N. Y	965
Helme & McIlhenny, Philadelphia, Pa	967
John J. Griffin & Co., Philadelphia, Pa	968
Keystone Meter Co., Royersford, Pa	966
Nathaniel Tufts Meter Co., Boston, Mass	966
New York Improved Meter Co., New York City	968
Pittsburg Meter Co., East Pittsburg, Pa	965

PREPAYMENT METER ATTACHMENTS.

New York Improved Meter Co., New York City	968
Reeves Mfg. Co., New Haven, Conn	963

WATER METERS.

Pittsburg Meter Co., East Pittsburg, Pa	965

GAS AND WATER PIPES.

Davis & Farnum Mfg. Co., Waltham, Mass	960
Donaldson Iron Co., Emaus, Pa	962
Economical Gas Apparatus Construc'n Co., Toronto, Ont	959
R. D. Wood & Co., Philadelphia, Pa	962
Warren Foundry and Machine Co., New York City	962

GAS COALS.

Berwind-White Coal Mining Co., New York and Phila. 958
Perkins Co., New York City 958
Westmoreland Gas Coal Co., Philadelphia, Pa 959

SPECIALTIES FOR OIL AND PIPE LINES.

S. R. Dresser, Bradford, Pa 956

GAS MAIN STOPPERS.

Safety Gas Main Stopper Co., New York City 952

MAIN AND SERVICE LAYING.

Sullivan Bros., Flushing, N. Y. 914

GAS TAPPING MACHINES.

George Light, Dayton, O 962
H. Mueller Manufacturing Co., Decatur, Ills. 942

CANNEL COALS.

Perkins & Co., New York City 958

STOKING MACHINERY.

G. A. Bronder, New York City 957

CONVEYORS.

Cruse-Kemper Co., Philadelphia, Pa. 948
C. W. Hunt Company, New York City 949
Economical Gas Apparatus Construc'n Co., Toronto, Ont 959
G. A. Bronder, New York City 957
Kerr Murray Mfg. Co., Fort Wayne, Ind 961
The Gas Machinery Co., Cleveland, O. 944
The Jeffrey Manufacturing Co., Columbus, O. 958
Western Gas Construction Co., Fort Wayne, Ind. 944

CHARGING BARROWS & COAL WAGONS.

Davis & Farnum Mfg. Co., Waltham, Mass. 960
Kerr Murray Mfg Co., Fort Wayne, Ind. 961
Stacey Mfg. Co., Cincinnati, O. 963

GAS ENRICHERS.

Standard Oil Co., New York City, 915
The Sun Oil Co., Pittsburgh, Pa. 959

COKE CRUSHERS.

C. M. Keller, Columbus, Ind. 959
The Jeffrey Manufacturing Co., Columbus, O. 958

(Continued on page 942.)

Estimates furnished for the erection of complete gas works or the extension and modernizing of old works. All work warranted. Both water gas and coal gas.

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Draughtsman.

Constructing engineer, 7 years' experience in constructing and supervising gas plants, desires to change present position as draughtsman of gas company.

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Position Wanted.

Young man, 25, one year engineering at college, good experience with gas companies and appliances, would like to learn gas business, with chance of advancement. Excellent references. Address, "H. W. F.,"
1669-3 Care this Journal.

Position Wanted.

The advertiser, who is 35 years of age and married, desires a position with a company that needs the services of a man competent in every sense to take charge of its distribution department. Thoroughly up in drafting, and can take entire charge of its service and meter divisions. Refers by permission to Mr. C. H. Dickey, Maryland Meter Co., Baltimore, Md. Address, "J. O. J.,"
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Position Wanted.

A Capable Manager and Superintendent,

Now employed, desires a position as manager or superintendent of gas, or combined gas and electric plants, in city of 15,000 to 25,000 population. Successful record. Southern or Middle States location preferred.

Address, "P. T. A.,"
1641-tf Care this Journal.

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Position as Superintendent of Gas Company,

By young married man of 16 years' experience in all its branches. Is now superintendent of gas company of 30,000,000 cubic feet. Will have to give present company 60 days' notice. Best of references.
1652-tf Address, "CAPABLE," care this Journal.

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Young man, 29 years of age, wishes situation with gas company for main and service laying or pipe fitting on works. Capable of taking charge of men. Thirteen years' gas works experience. Good references. Address, "J. L.,"
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Situation Wanted.

Expert gas, electric and railway accountant, also auditor, statistician and new business manager, good systemizer and reorganizer, would like to connect with reliable gas or electric company. Formerly employed as supervising accountant and auditor of a Wall Street banking house.

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Experienced in all lines of the trade, including instantaneous water heaters and piping from prints. Steady work and good pay for good men. Address, CALUMET GAS CO.,
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WANTED,

Retort House Man for Straight Coal Gas Works

Delivering under both high and low pressure. Must be familiar with Westinghouse compressors and pumps necessary in plant of this character. Two benches inclined 4's now working. Write for further information and terms. References required.

Address, CALUMET GAS COMPANY,
1667-tf LAURIUM, MICH.

WANTED,

A Station Meter in Good Condition for Immediate Use.

Not less than 10 feet diameter.

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FOR SALE.

Two Sets of Purifiers, 4 boxes in each set. Size 16 feet by 24 feet by 4 feet deep; 24-inch seals; 20-inch connections; rotary center valve and by-pass.

Also one Set of Four Purifiers, 20 feet by 20 feet by 30 inches deep; 24-inch seals; 16-inch connections; rotary center valve.

All the above boxes are complete, with covers, lifting carriages and reversible trays.

Also Four Station Meters, as follows:

One 12 feet diameter by 12 feet 2 inches long; 20-inch connections

One 11 feet 6 inches diameter by 11 feet 6 inches long; 16-inch connections.

Two 8 feet 6 inches diameter by 7 feet long; 12-inch connections.

All the above station meters have 4 partitions and were built by the American Meter Company.

One 10 feet diameter case.
One 12 feet diameter meter case.
Two second-hand No. 4 Roots' blowers.
One second-hand 24-inch MacKenzie exhauster

Also Two Single-Lift Gasholders in brick tanks, 50,000 cubic feet capacity each, and giving about 5½ inches pressure.

For further information, apply to

GEORGE BEADENKOPF, Engineer,
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FOR SALE,

One 4-foot Granger-Collins Water Gas Set.

WINSTED GAS COMPANY,
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Comprising Tables, Notes and Memoranda relating to the Manufacture, Distribution and Use of Coal Gas, and the Construction of Gas Works.

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A. M. CALLENDER & CO., 42 Pine Street, New York City.

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what size of pipe to use to convey any quantity of gas, any distance, with any loss of pressure and any initial or final pressure? Then use

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GAS ENGINES,

With Instructions for Care and Working of the Same,

By G. LIECKFELD, C.E.

Translated with Permission of the Author,
By GEO. M. RICHMOND, M.E.

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For Students in Gas Manufacture.

ELEMENTARY, ADVANCED AND CONSTRUCTIONAL.

Three Volumes. Price, $1.50 each. For Sale by
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42 Pine Street, New York City.

M. J. LOXLEY COMPANY,
BANKERS,
Land Title Building, Philadelphia, Pa.

GAS AND ELECTRIC PROPERTIES PURCHASED AND SOLD.

(Concluded from page 941.)

GAS METER CONNECTIONS.

H. Mueller Manufacturing Co., Decatur, Ills. 942

GAS COCKS.

H. Mueller Manufacturing Co., Decatur, Ills. 942

GAS GAUGES.

The Bristol Co., Waterbury, Conn. 949

GAS GOVERNORS.

Chaplin-Fulton Mfg. Co., Pittsburgh, Pa. 952
Connelly Iron Sponge & Governor Co., New York City. 947
Isbell-Porter Co., Newark, N. J. 948
Pittsburg Meter Co., East Pittsburg, Pa. 965
R. D. Wood & Co., Philadelphia, Pa. 962
Reynolds Gas Regulator Co., Anderson, Ind. 946

FUEL ECONOMIZERS.

Green Fuel Economizer Co., Matteawan, N. Y. 949

CEMENTS.

C. L. Gerould, Pittsburgh, Pa. 946

RETORTS AND FIREBRICKS.

Baltimore Retort and Firebrick Co., Baltimore, Md. 946
Gas Bench Construction Co., St. Louis, Mo. 946
Henry Maurer & Son, New York City. 949
James Gardner, Jr., Co., Pittsburgh, Pa. 946
J. H. Gautier & Co., Jersey City, N. J. 946
Laclede Firebrick Mfg. Co., St. Louis, Mo. 947
Missouri Firebrick Co., St. Louis, Mo. 946
National Pyrogranit Co., New York City. 946
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 945

INCLINED RETORTS.

Baltimore Retort and Firebrick Co., Baltimore, Md. 946
Gas Bench Construction Co., St. Louis, Mo. 946
Laclede Firebrick Mfg. Co., St. Louis, Mo. 947
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 945

VERTICAL S'S.

Connelly Iron Sponge & Gov. Co. (Drake's [Eng.] System) 947
Gas Bench Construction Co., St. Louis, Mo. 946
Laclede Firebrick Mfg. Co., St. Louis, Mo. 947
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 945

REGENERATIVE FURNACES.

Baltimore Retort and Firebrick Co., Baltimore, Md. 946
Bartlett, Hayward & Co., Baltimore, Md. 961
Gas Bench Construction Co., St. Louis, Mo. 946
J. H. Gautier & Co., Jersey City, N. J. 946
Laclede Firebrick Mfg. Co., St. Louis, Mo. 947
Missouri Firebrick Co., St. Louis, Mo. 946
Parker-Russell Mining and Mfg. Co., St. Louis, Mo. 945

SELF-SEALING MOUTHPIECE DOORS.

Continental Iron Works, Brooklyn, N. Y. 962
Davis & Farnum Mfg. Co., Waltham, Mass. 960
Isbell-Porter Co., Newark, N. J. 948
Kerr Murray Mfg. Co., Fort Wayne, Ind. 961
Logan Iron Works, Brooklyn, N. Y. 964
R. D. Wood & Co., Philadelphia, Pa. 962
Stacey Mfg. Co., Cincinnati, O. 963
The Gas Machinery Co., Cleveland, O. 914
Western Gas Construction Co., Fort Wayne, Ind. 924

INCANDESCENT GAS LAMPS.

General Gas Light Co., Kalamazoo, Mich. 951
Geo. G. Ramsdell, New York City. 946
Welsbach Company, Gloucester, N. J. 954

BURNERS.

Wm. M. Crane Co., New York City. 946

STREET LAMPS.

Thos. T. W. Miner, New York City. 952
Welsbach Street Lighting Co., New York and Phila. 954

PURIFIERS.

Connelly Iron Sponge & Governor Co., New York City. 957
Cruse-Kemper Co., Philadelphia, Pa. 948
Davis & Farnum Mfg. Co., Waltham, Mass. 960
Isbell-Porter Co., Newark, N. J. 948
Kerr Murray Mfg. Co., Fort Wayne, Ind. 961
R. D. Wood & Co., Philadelphia, Pa. 962
Stacey Mfg. Co., Cincinnati, O. 963
Western Gas Construction Co., Fort Wayne, Ind. 924

PURIFYING MATERIALS.

Connelly Iron Sponge & Governor Co., New York City. 957

VALVES.

Continental Iron Works, Brooklyn, N. Y. 962
Davis & Farnum Mfg. Co., Waltham, Mass. 960
Economical Gas Apparatus Construc'n Co, Toronto, Ont 959
Isbell Porter Co., Newark, N. J. 948
Kerr Murray Mfg. Co., Fort Wayne, Ind 961
Ludlow Valve Manufacturing Co., Troy, N. Y. 949
R. D. Wood & Co., Philadelphia, Pa. 962
Stacey Mfg. Co., Cincinnati, O. 963
The P. H. & F. M. Roots Co., Connersville, Ind. 911
Western Gas Construction Co., Fort Wayne, Ind. 924

EXHAUSTERS.

Connelly Iron Sponge & Governor Co., New York City. 957
Connersville Blower Co., Connersville, Ind. 959
Davis & Farnum Mfg. Co., Waltham, Mass. 960
Isbell-Porter Company, Newark, N. J. 948
Kerr Murray Mfg. Co., Fort Wayne, Ind. 961
The P. H. & F. M. Roots Co., Connersville, Ind. 951

PURIFIER AND SCRUBBER TRAYS.

Cabot Mfg. Co., Hoboken, N. J. 959
Western Gas Construction Co., Fort Wayne, Ind. 924

GAS STOVES.

American Meter Co., New York and Philadelphia 967
Keystone Meter Co., Royersford, Pa. 966
Maryland Meter & Manufacturing Co., Baltimore, Md. 966
Nathaniel Tufts Meter Co., Boston, Mass. 966

HOT WATER HEATERS.

Humphrey Co., Kalamazoo, Mich. 947

GASHOLDER TANKS.

J. P. Whittier, Brooklyn, N. Y. 962

GASHOLDERS.

Bartlett, Hayward & Co., Baltimore, Md. 961
Continental Iron Works, Brooklyn, N. Y. 962
Cruse-Kemper Co., Philadelphia, Pa. 948
Davis & Farnum Mfg. Co., Waltham, Mass. 960
Del'y & Fowler, Philadelphia, Pa. 964
Economical Gas Apparatus Construc'n Co., Toronto, Ont 959
Kerr Murray Mfg. Co., Fort Wayne, Ind. 961
Logan Iron Works, Brooklyn, N. Y. 964
R. D. Wood & Co., Philadelphia, Pa. 962
Riter-Conley Mfg Co., Pittsburgh, Pa. 963
Stacey Mfg. Co., Cincinnati, O. 963
Western Gas Construction Co., Fort Wayne, Ind. 924

STORAGE TANKS.

Davis & Farnum Mfg. Co., Waltham, Mass. 960
Stacey Mfg. Co., Cincinnati, O. 963
Western Gas Construction Co., Fort Wayne, Ind. 924

PAINTS.

American Standard Composition Co., New York City. 960

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Utilize Your Gas Liquor.

NO EXTRA LABOR OR OPERATING EXPENSES.

IMPROVED AMMONIA CONCENTRATOR.

About 100 in use. Write to

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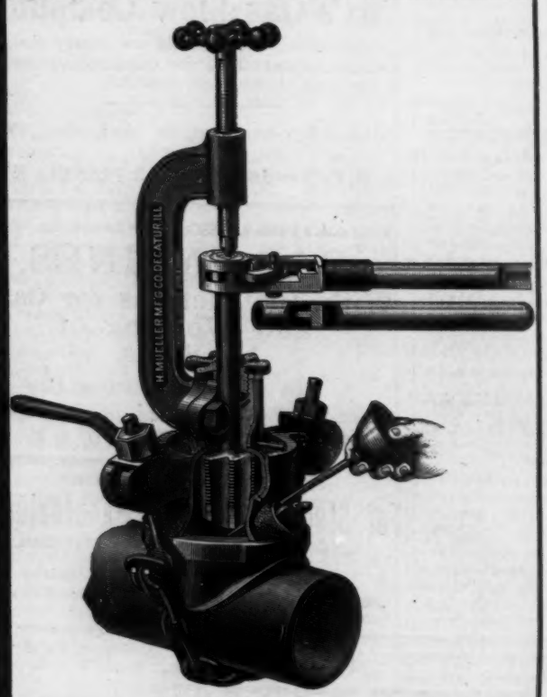

MAKES TAPS UP TO 3 INCHES.

A TALK ABOUT TAPPERS.

If you have no use for a tapping machine you don't need one. But if you have use for one you certainly need a MUELLER MACHINE.

BECAUSE

They are solidly built and do the work fast and clean cut.

They are superior—there is none better—none just as good.

They are given an actual working test before leaving the factory and we KNOW they are RIGHT.

They are made for making taps up to 4 inches.

They will do better everything that any other machine will do, and without giving you any trouble.

Consider these facts. It's to your interest.

Unconditionally Guaranteed.

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If your old machine needs attention send it in. We will make it practically as good as new at moderate cost.

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The 4,000,000 Cubic Foot Per Day

ROTARY STATION METER

FOR THE

CONSOLIDATED GAS COMPANY OF NEW YORK.

Dimensions: Base 84 in.; Face to Face, Flanges 108 in.; Height 99½ in.; Connections 20 in.

The above illustration was made from a photograph taken at the Manchester works of our English company on the day (Aug. 11) this meter was shipped.

This ***Four Million*** foot Rotary Meter is about to be installed at the 21st Street station of the Consolidated Gas Company in the City of New York.

One-half the Cost—One-tenth the Space.

When in Need of Station Meters

write

ROTARY METER COMPANY,

280 Broadway,

NEW YORK.

P. PLANTINGA, President W. E. STEINWEDELL, Secretary

THE GAS MACHINERY CO.,

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CLEVELAND, OHIO.

NEW YORK OFFICE, - - 56 PINE STREET.

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EXHAUSTERS, CONDENSERS, SCRUBBERS,
TAR EXTRACTORS, WASHERS, PURIFIERS,
VALVES, CONNECTIONS,
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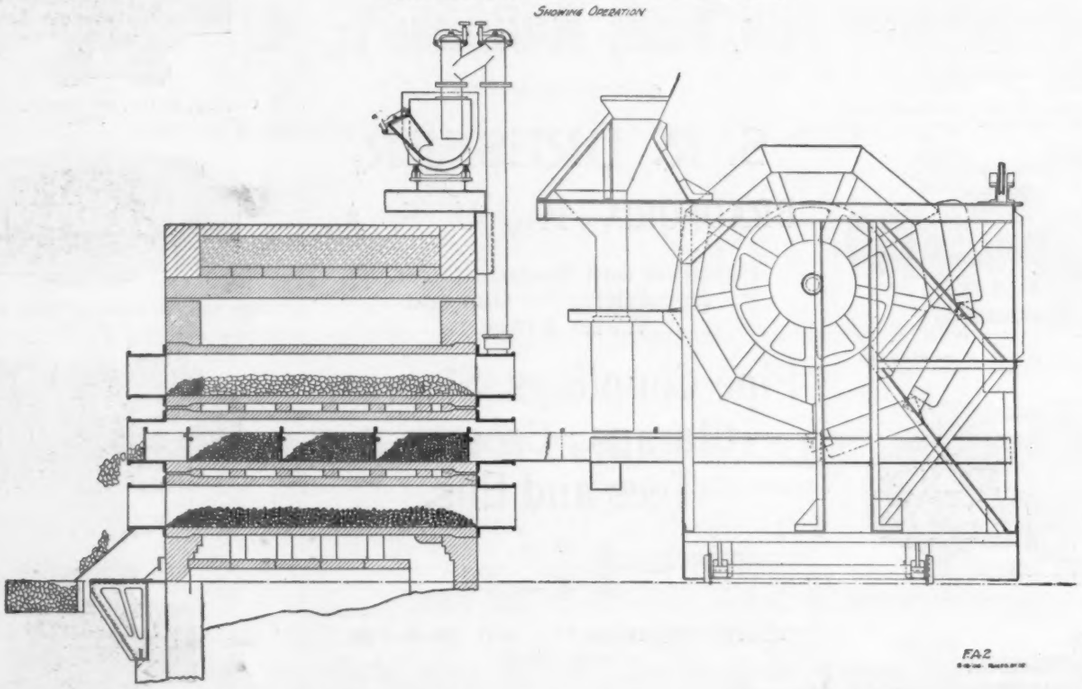
GAS RETORTS AND FIREBRICK.

We Manufacture Gas Retorts and Settings, Furnace Blocks and Fireclay Tiles of every description.

FIDDES-ALDRIDGE SIMULTANEOUS RETORT DISCHARGING-CHARGER
SHOWING OPERATION



Benches.--We erect GAS RETORT BENCHES with Horizontal retorts having closed ends up to 10 feet in length, or Through retorts up to 20 feet in length.

Slopers.--Also, SLOPERS on improved lines for Inclined Retorts.

Stoking Machinery.--Sole Agents for U. S. and Canada for the Fiddes-Aldridge Simultaneous Discharging Charger. The "F. A.," or "One-Stroke" Machine. Cost of Carbonizing reduced to minimum. No Dust. Silent. No Waste of Coal. No Injury to Retorts.

Water Gas Linings.--We make a specialty of WATER GAS BLOCKS, and supply brick of superior grade for checkerwork.

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Retort Houses and Conveying Machinery.--We also build Retort Houses, Coal and Coke Conveying Machinery. Plans, specifications and estimates cheerfully furnished.

CORRESPONDENCE SOLICITED.

ALL CONTRACTS MADE, AS OF ST. LOUIS.

Bray's Union-Jet.

NOTHING SUCCEEDS LIKE SUCCESS.

BRAY BURNERS

Are made by a company that makes **more open flame** burners than **any other concern in the world.**

The makers of the **BRAY** only make burners, and, knowing how, they make the best.

When you buy **BRAY BURNERS** you buy **durability, efficiency** and **satisfaction,** both for **yourself** and your **consumer.**

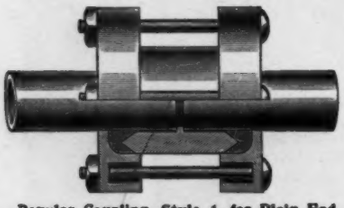
There is 40 years of experience back of every Bray Burner.

W. M. CRANE COMPANY,

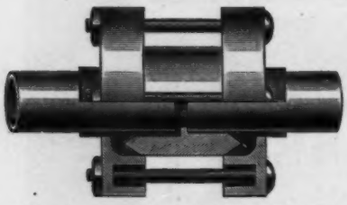
1131-33 Broadway, New York, N. Y.,

WE MAKE GAS APPLIANCES OF ALL KINDS. Sole Agents for Bray Burners in the U. S. and Canada.

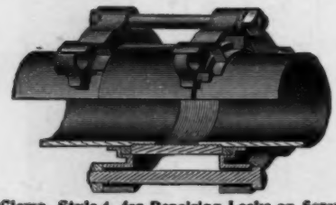
Self-Lighting Burner.



Regular Coupling, Style 1, for Plain End Wrought Iron Pipe.



Insulating Coupling, Style 5, for Plain End Wrought Iron Pipe,



Clamp, Style 4, for Repairing Leaks on Screw Collar.

Long Sleeve, Style 2, for Mending Broken Lines.

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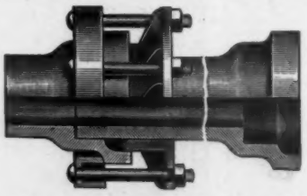
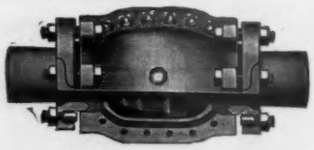
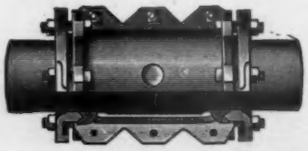


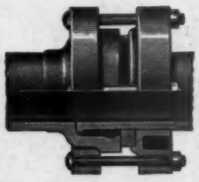
Coupling, Style 9, for Special Style Cast Iron Pipe.



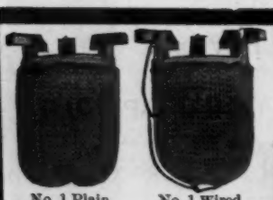
Split Sleeve for Repairing Broken Bell on Cast Iron Pipe.



Split Sleeve for Repairing Broken or Cracked Cast Iron Pipe.



Clamp, Style 4½, for Repairing Leaky Lead or Cement Joints in Cast Iron Pipe.



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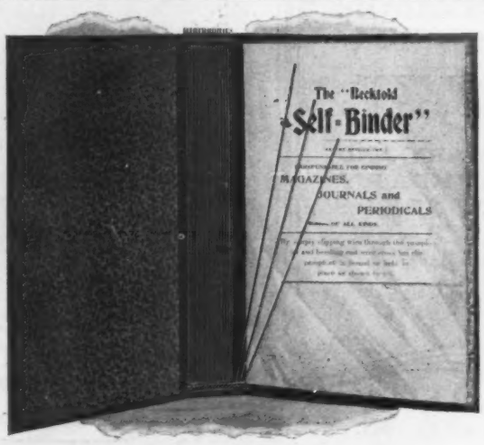

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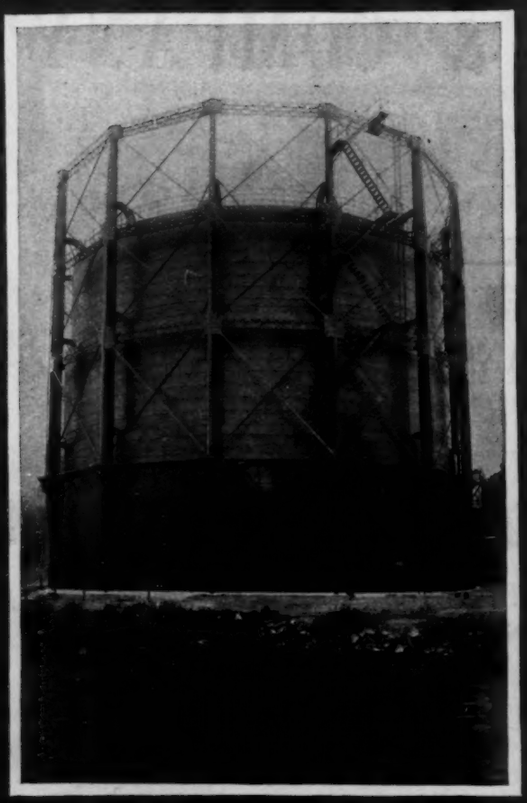

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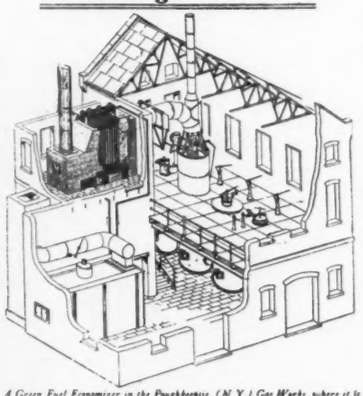

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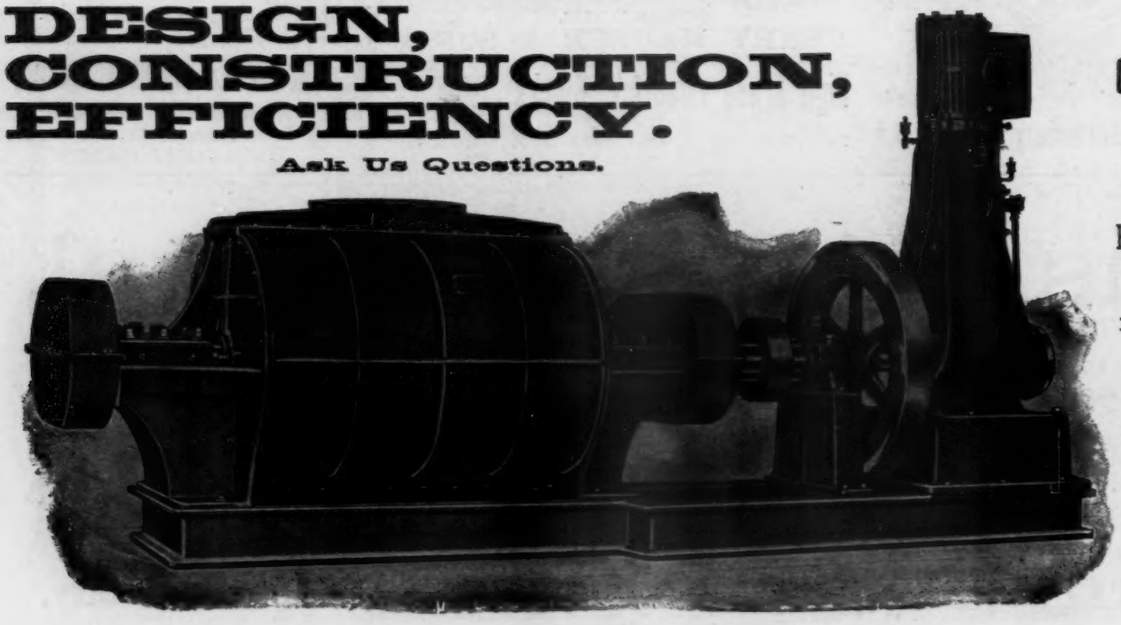

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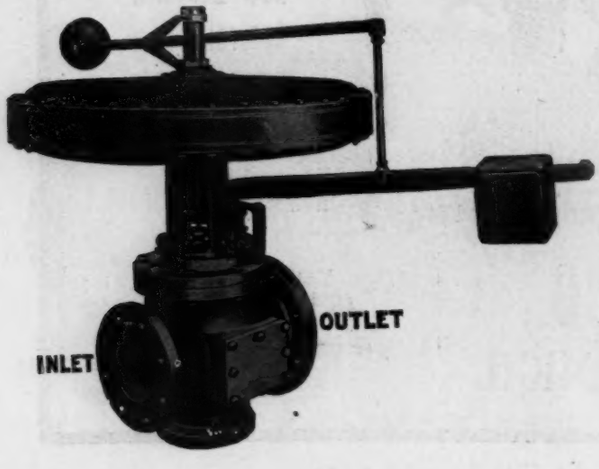

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PUBLIC LIGHTING TABLE.

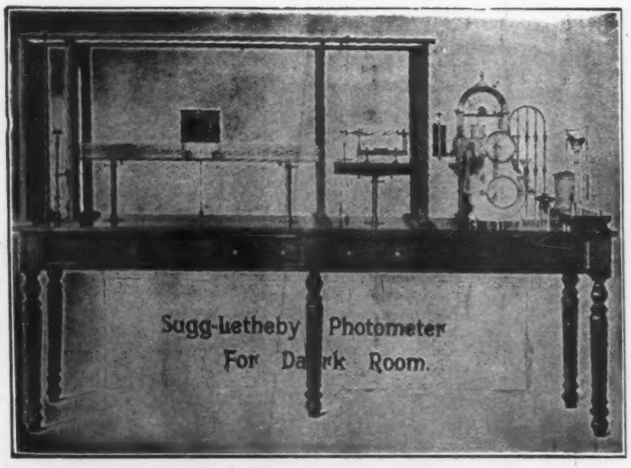
JUNE, 1907.

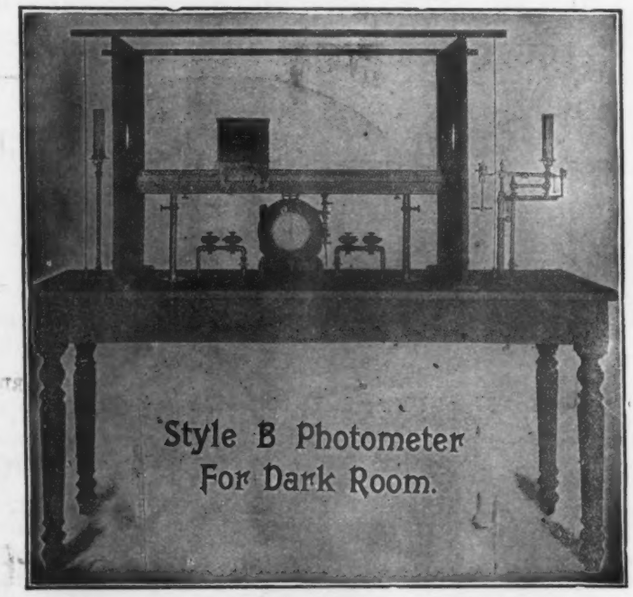
Day of Week.	Date.	Table No. 1. FOLLOWING THE MOON. Light.	Extinguish.
Sat.	1	7.50 PM	1.20 AM
Sun.	2	7.50 LQ	1.50
Mon.	3	7.50	2.20
Tue.	4	7.50	2.50
Wed.	5	7.50	3.20
Thu.	6	7.50	3.30
Fri.	7	7.50	3.30
Sat.	8	7.50	3.30
Sun.	9	8.00	3.30
Mon.	10	8.00 NM	3.30
Tue.	11	8.00	3.30
Wed.	12	8.00	3.30
Thu.	13	8.00	3.30
Fri.	14	8.00	3.30
Sat.	15	10.00	3.30
Sun.	16	10.30	3.30
Mon.	17	11.00	3.30
Tue.	18	11.30 FQ	3.30
Wed.	19	12.00	3.30
Thu.	20	12.30 AM	3.30
Fri.	21	1.00	3.30
Sat.	22	1.40	3.30
Sun.	23	2.20	3.30
Mon.	24	No L.	No L.
Tue.	25	No L FM	No L.
Wed.	26	No L.	No L.
Thu.	27	8.00 PM	10.30 PM
Fri.	28	8.00	11.10
Sat.	29	8.00	11.50
Sun.	30	8.00	12.30 AM

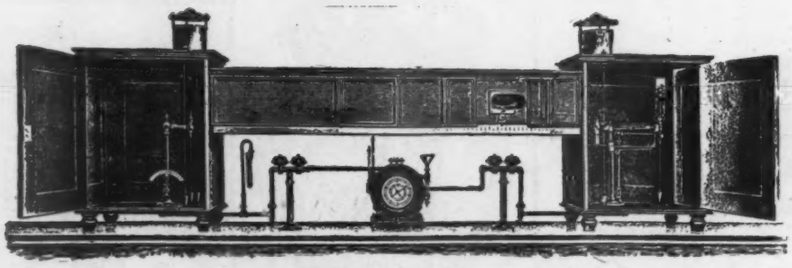
TOTAL HOURS DURING 1907.

By Table No. 1.

	Hrs.Min.
January	211.10
February	193.40
March	182.10
April	167.00
May	157.00
June	145.30
July	151.50
August	162.30
September	175.30
October	202.40
November	209.30
December	231.50
Total, yr.	2190.20







Closed Photometer For Light Room.

CIRCULARS SENT ON REQUEST.

PUBLIC LIGHTING TABLE.

JUNE, 1907.

Day of Week.	Date.	Table No. 2. NEW YORK CITY. All Night Lighting. Light	Extinguish.
		P. M.	A.M.
Sat.	1	7.15	3.15
Sun.	2	7.15	3.15
Mon.	3	7.15	3.15
Tue.	4	7.25	3.15
Wed.	5	7.25	3.15
Thu.	6	7.25	3.15
Fri.	7	7.25	3.15
Sat.	8	7.25	3.15
Sun.	9	7.25	3.15
Mon.	10	7.25	3.15
Tue.	11	7.25	3.15
Wed.	12	7.25	3.15
Thu.	13	7.25	3.15
Fri.	14	7.25	3.15
Sat.	15	7.25	3.15
Sun.	16	7.25	3.15
Mon.	17	7.25	3.15
Tue.	18	7.30	3.15
Wed.	19	7.30	3.15
Thu.	20	7.30	3.15
Fri.	21	7.30	3.15
Sat.	22	7.30	3.15
Sun.	23	7.30	3.15
Mon.	24	7.30	3.15
Tue.	25	7.30	3.15
Wed.	26	7.30	3.15
Thu.	27	7.30	3.15
Fri.	28	7.30	3.15
Sat.	29	7.30	3.15
Sun.	30	7.30	3.15

TOTAL HOURS DURING 1907.

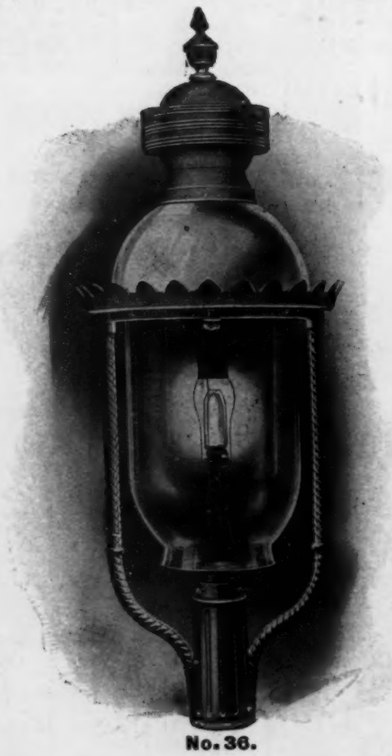
By Table No. 2.

	Hrs.Min.
January	423.20
February	355.25
March	355.35
April	298.50
May	264.50
June	234.25
July	243.45
August	280.25
September	321.15
October	374.30
November	401.40
December	433.45
Total, yr.	3987.45

NEW YORK, 318 West 42d Street. BOSTON, 820 Beacon Building. PHILADELPHIA, Broad and Arch Streets. ST. LOUIS, 712 Roe Building. CHICAGO, 218 La Salle Street. SAN FRANCISCO, 512 Oak Street.

WELSBACH STREET LIGHTING COMPANY

....OF AMERICA....



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St. Johnsbury, Vt.
Memphis, Tenn. (2d contract).
Council Bluffs, Ia. (2d contract).
Seattle, Wash. (2d contract).
Philadelphia, Pa.
Waterbury, Conn.
Manchester, N. H.
Allentown, Pa.
Omaha, Neb.
Muskegon, Mich.
Nazareth, Pa. (2d contract).
Lewistown, Pa.
Greenville, Tex.
New York, Cent. Un. (3d contract).
Jefferson City, Mo.
Peekskill, N. Y. (2d contract).
Waterville, Me.
Washington, D. C. (4th contract).
Lawrence, Mass. (3d contract).
Hampton, Va.
Aurora, Ills. (2d contract).
Milwaukee, Wis.
Syracuse, N. Y. (2d contract).
Davenport, Ia.
S. Brooklyn, N. Y. (3d contract).
Delray, Mich.
Albert Lea, Minn. (2d contract).
Leominster, Mass. (2d contract).
Clinton, Mass.

TOTAL SETS INSTALLED IN 1906, ... 41
TOTAL SETS TO DATE, ... 634
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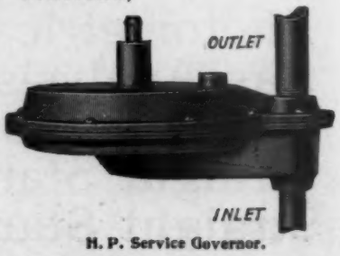

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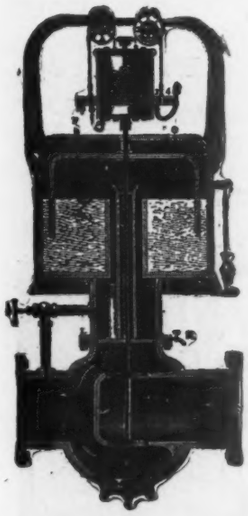

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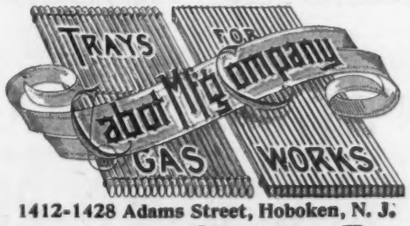

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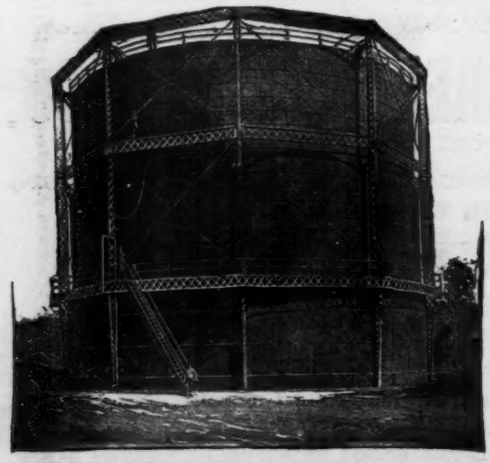

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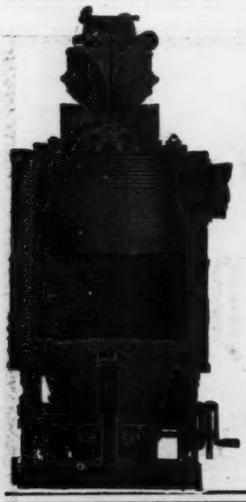

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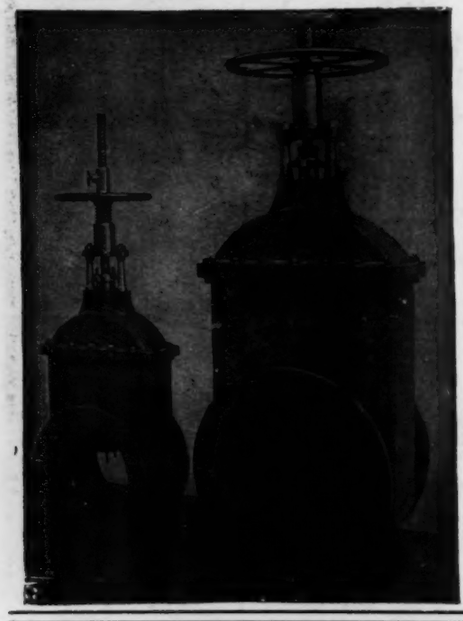

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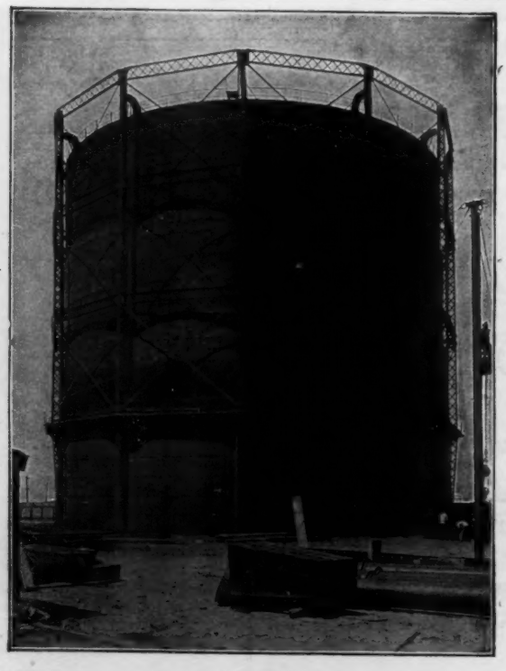

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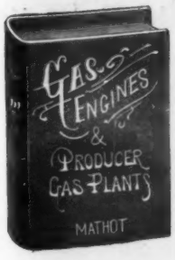

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